

Series
myPatent
LEADERS *of* TOMORROW
ELECTRICAL AND COMPUTER ENGINEERING, UNIVERSITY OF TORONTO

Patent Use & Patent Creation

Prof. Vaughn Betz

ECE Department

Feb. 9, 2012



Patent Overview

Basics of Patents

- Give protection (**exclusivity**) to creator of an invention in exchange for **disclosure** of invention
- Must:
 - Be “non-obvious” enhancement to prior art
 - To one of typical skill in the area
 - Description must “enable” implementation
 - Can’t be too vague
 - Can’t be impossible (perpetual motion machine)

Protection Jurisdiction

- Patents mostly national (exception: Europe)
- US patent usually enough protection
 - Could violate patent if you never ship to US
 - But cuts you off from largest market
- Next most important: Europe
 - 38 countries (entire EU, Turkey, Switzerland, ...)
- My patents: mostly US-only
 - A few key ones (heart of shipping chips) also filed in Europe and Japan

Protection & Cost

- US Patent
 - 20 years exclusivity from date of filing
 - Published 18 months after filing (disclosure)
- Cost:
 - Filing / examination fees: ~\$1400
 - More if *complex claims* (+\$1000 to \$2000)
 - Maintenance fees: ~\$9000
 - Legal fees: ~10,000
 - Total: ~\$20,000 typical
 - <http://www.uspto.gov/web/offices/ac/qs/ope/fee092611.htm>

Alternatives to Patenting



1. Trade secret

- Don't tell anyone
- Hope they never figure out your secret sauce
- Usually does not count as “prior art”
 - Risk: someone else can patent it!

2. Publish

- Disclose invention: no one else can patent it
- Publish a paper, or put on a web site
- Opposite of trade secret!

Alternatives to Patenting



3. Copyright

- Automatic for written works
 - Including computer software
- Illegal to copy the source code
- But can design around it: re-code same idea

Value of Patent

- Breadth of applicability?
 - Is the idea so specialized no one will ever exactly copy it?
 - E.g. software to use a hardware feature found only in an Altera chip – will anyone else ever use?
- Visibility of infringement?
 - Can you detect when someone violates?
 - E.g. Quartus II software feature ✓
 - FPGA chip circuitry ✓
 - Chip construction flow ✗

Value of Patent

- Design alternatives (narrow patent)?
 - Is it easy to find other ways to accomplish the same thing?
 - E.g. patent a graphical user interface with round windows
 - Can design around with rectangles, ovals, hexagons, etc – reduces value

Patent Litigation

- Can sue for damages (lost sales etc.) if someone infringes your patent
- Can get triple damages if you show the infringement was intentional
 - They knew of your patent
 - Some companies discourage patent searches by engineers because of this
- Can get an injunction to stop sales of infringing product while litigation underway
 - Big deal! Can kill a hot product

Patent Uses

- Discourage / prevent possible competitors
 - Can't copy your product
 - If patent broad enough, can help keep them out of your market
 - E.g. Apple vs. Samsung for iPad
 - Need to be willing to litigate to enforce
 - Years to resolve, many \$\$
 - Can be a problem for small companies

Patent Uses

- Defensive
 - Big patent portfolio → others won't sue you
 - Free to exploit your market
 - Main use of patents at Altera
 - Litigation often leads to cross-licensing if both sides strong
 - Xilinx vs. Altera: ~5 years, ~\$20M each / year in legal fees
 - Each infringed the others' patents
 - Settled in 2001 with cross-license
 - Zilog vs. Altera
 - Zilog sued Altera. Altera counter-sued on another patent.
 - Zilog forced to pay Altera fees to settle
 - Be careful suing someone with a strong patent portfolio!

Patent Uses



- Licensing revenue
 - Make money in patent royalties
 - TI: ~\$1B / year from DRAM patents
 - Some companies only license: patent trusts (or trolls)
 - Mosaid, Rambus (DRAM), NTP (wireless email)
 - Can't countersue (no products)
 - Not interested in cross-license
 - More difficult to deal with
- RIM vs. NTP: dangerous to fight, even if patents look invalid
 - A few million license became \$612.5 M settlement

Patent Uses



- Small company
 - Some defense against others copying
 - Some defense against others asserting their patents against you
 - Increases value of company for IPO or acquisition
 - Companies may acquire for patent portfolio

First to Invent: Do's and Don'ts

- US: first to invent patent
- Rest of world: first to file
- Document your work to support first-to-invent
 - In case two patents filed close in time
- Notes in lab book from which pages can't be added/removed
 - Used to prove I was first to invent an FPGA circuit idea in my PhD
 - Other patent inspired by discussion with me!
- Amr Mohsen, CEO Aptix
 - Patent infringement lawsuit
 - Had notebooks showing he was first to invent
 - Ink not in use at date on lab book
 - Jailed for perjury!



Creating a Patent

Parts of a Patent

- Title
 - Choose a good one – it'll be on your CV
- Inventors
 - List of those who made invention
 - Can't leave off inventors
 - Can't include non-inventors (did not significantly contribute)
 - Wrong inventors → grounds to invalidate patent
- Technical Field
 - General area of the invention (brief)
- Abstract (short summary)
 - Write last

Parts of a Patent

- Background and Prior Art
 - What has been done before in the area, and what is the unmet need?
- Brief Summary of the Invention
 - How does your invention solve the unmet need, and go beyond the prior art
- Brief Description of the Drawings
 - List of Figures

Parts of a Patent

- Detailed description of invention
 - Must be detailed enough for someone of reasonable skill in the art to reproduce
 - Can include various options / alternatives
 - Longest part of patent
- Figures
 - In the detailed description, and often in the summary of the invention
 - All labels are numbers, and meaning of numbers are defined in the text
- Claims
 - What you “claim” an exclusive right to
 - Must not cover any prior art
 - Must be enabled (can figure out how to do) by your detailed description

Example (S. Jobs, Apple)

Touch screen device, method, and graphical user interface for determining commands by applying heuristics

Abstract: A computer-implemented method for use in conjunction with a computing device with a touch screen display comprises: detecting one or more finger contacts with the touch screen display, applying one or more heuristics to the one or more finger contacts to determine a command for the device, and processing the command. The one or more heuristics comprise: a heuristic for determining that the one or more finger contacts correspond to a one-dimensional vertical screen scrolling command, a heuristic for determining that the one or more finger contacts correspond to a two-dimensional screen translation command, and a heuristic for determining that the one or more finger contacts correspond to a command to transition from displaying a respective item in a set of items to displaying a next item in the set of items.

(12) **United States Patent**
Jobs et al.

(10) **Patent No.:** **US 7,479,949 B2**
(45) **Date of Patent:** ***Jan. 20, 2009**

(54) **TOUCH SCREEN DEVICE, METHOD, AND GRAPHICAL USER INTERFACE FOR DETERMINING COMMANDS BY APPLYING HEURISTICS**

(75) Inventors: **Steven P. Jobs**, Palo Alto, CA (US); **Scott Forstall**, Mountain View, CA (US); **Greg Christie**, San Jose, CA (US); **Stephen O. Lemay**, San Francisco, CA (US); **Scott Herz**, San Jose, CA (US); **Marcel van Os**, San Francisco, CA (US); **Bas Ording**, San Francisco, CA (US); **Gregory Novick**, Santa Clara, CA (US); **Wayne C. Westerman**, San Francisco, CA (US); **Imran Chaudhri**, San Francisco, CA (US); **Patrick Lee Coffman**, Menlo Park, CA (US); **Kenneth Kocienda**, Sunnyvale, CA (US); **Nitin K. Ganatra**, San Jose, CA (US); **Freddy Allen Anzures**, San Francisco, CA (US); **Jeremy A. Wyld**, San Jose, CA (US); **Jeffrey Bush**, San Jose, CA (US); **Michael Matas**, San Francisco, CA (US); **Paul D. Marcos**, Los Altos, CA (US); **Charles J. Pisula**, San Jose, CA (US); **Virgil Scott King**, Mountain View, CA (US); **Chris Blumenberg**, San Francisco, CA (US); **Francisco Ryan Tolmasky**, Cupertino, CA (US); **Richard Williamson**, Los Gatos, CA (US); **Andre M. J. Boule**, Sunnyvale, CA (US); **Henri C. Lamiroux**, San Carlos, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/101,832**

(22) Filed: **Apr. 11, 2008**

(65) **Prior Publication Data**
US 2008/0174570 A1 Jul. 24, 2008

Related U.S. Application Data

(63) Continuation of application No. 11/850,635, filed on Sep. 5, 2007.

(60) Provisional application No. 60/937,993, filed on Jun. 29, 2007, provisional application No. 60/937,991, filed on Jun. 29, 2007, provisional application No. 60/879,469, filed on Jan. 8, 2007, provisional application No. 60/879,253, filed on Jan. 7, 2007, provisional application No. 60/824,769, filed on Sep. 6, 2006.

(51) **Int. Cl.**
G09G 5/00 (2006.01)
G06F 3/048 (2006.01)

(52) **U.S. Cl.** **345/173; 345/169; 715/786; 715/784**

(58) **Field of Classification Search** **345/156, 345/157, 173-181**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,528,260 A *	6/1996	Kent	345/684
5,655,094 A *	8/1997	Cline et al.	715/786
5,805,161 A *	9/1998	Tiphane	715/786
6,278,443 B1	8/2001	Amro et al.	345/173
6,466,203 B2	10/2002	Van Ee	345/173
6,559,869 B1 *	5/2003	Lui et al.	715/785
6,597,345 B2 *	7/2003	Hirshberg	345/168
6,657,615 B2	12/2003	Harada	345/173
6,683,628 B1 *	1/2004	Nakagawa et al.	715/799
6,690,387 B2	2/2004	Zimmerman et al.	345/684
7,088,344 B2	8/2006	Maezawa et al.	345/173
7,093,203 B2	8/2006	Mugura et al.	715/864
2002/0158838 A1	10/2002	Smith et al.	345/156
2003/0184593 A1	10/2003	Dunlop	345/810
2004/0012572 A1	1/2004	Sowden et al.	345/173
2004/0021676 A1	2/2004	Chen et al.	345/684
2004/0160420 A1	8/2004	Baharav	345/173
2005/0012723 A1	1/2005	Pallakoff	345/173
2005/0193351 A1	9/2005	Huoviala	715/840

TOUCH SCREEN DEVICE, METHOD, AND GRAPHICAL USER INTERFACE FOR DETERMINING COMMANDS BY APPLYING HEURISTICS

RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 11/850,635, "Touch Screen Device, Method, and Graphical User Interface for Determining Commands by Applying Heuristics," filed Sep. 5, 2007, which claims the benefit of U.S. Provisional Patent Application Nos. 60/937,991, "Touch Screen Device, Method, and Graphical User Interface for Determining Commands by Applying Heuristics," filed Jun. 29, 2007; 60/937,993, "Portable Multifunction Device," filed Jun. 29, 2007; 60/879,469, "Portable Multifunction Device," filed Jan. 8, 2007; 60/879,253, "Portable Multifunction Device," filed Jan. 7, 2007; and 60/824,769, "Portable Multifunction Device," filed Sep. 6, 2006. All of these applications are incorporated by referenced herein in their entirety.

This application is related to the following applications: (1) U.S. patent application Ser. No. 10/188,182, "Touch Pad For Handheld Device," filed Jul. 1, 2002; (2) U.S. patent application Ser. No. 10/722,948, "Touch Pad For Handheld Device," filed Nov. 25, 2003; (3) U.S. patent application Ser. No. 10/643,256, "Movable Touch Pad With Added Functionality," filed Aug. 18, 2003; (4) U.S. patent application Ser. No. 10/654,108, "Ambidextrous Mouse," filed Sep. 2, 2003; (5) U.S. patent application Ser. No. 10/840,862, "Multipoint Touchscreen," filed May 6, 2004; (6) U.S. patent application Ser. No. 10/903,964, "Gestures For Touch Sensitive Input Devices," filed Jul. 30, 2004; (7) U.S. patent application Ser. No. 11/038,590, "Mode-Based Graphical User Interfaces For Touch Sensitive Input Devices," filed Jan. 18, 2005; (8) U.S. patent application Ser. No. 11/057,050, "Display Actuator," filed Feb. 11, 2005; (9) U.S. Provisional Patent Application No. 60/658,777, "Multi-Functional Hand-Held Device," filed Mar. 4, 2005; (10) U.S. patent application Ser. No. 11/367,749, "Multi-Functional Hand-Held Device," filed Mar. 3, 2006; and (11) U.S. patent application Ser. No. 29/281,695, "Icons, Graphical User Interfaces, and Animated Graphical User Interfaces For a Display Screen or Portion Thereof," filed Jun. 28, 2007. All of these applications are incorporated by reference herein in their entirety.

TECHNICAL FIELD

The disclosed embodiments relate generally to electronic devices with touch screen displays, and more particularly, to electronic devices that apply heuristics to detected user gestures on a touch screen display to determine commands.

BACKGROUND

As portable electronic devices become more compact, and the number of functions performed by a given device increase, it has become a significant challenge to design a user interface that allows users to easily interact with a multifunction device. This challenge is particular significant for handheld portable devices, which have much smaller screens than desktop or laptop computers. This situation is unfortunate because the user interface is the gateway through which users receive not only content but also responses to user actions or behaviors, including user attempts to access a device's features, tools, and functions. Some portable communication devices (e.g., mobile telephones, sometimes called mobile

phones, cell phones, cellular telephones, and the like) have resorted to adding more pushbuttons, increasing the density of push buttons, overloading the functions of pushbuttons, or using complex menu systems to allow a user to access, store and manipulate data. These conventional user interfaces often result in complicated key sequences and menu hierarchies that must be memorized by the user.

Many conventional user interfaces, such as those that include physical pushbuttons, are also inflexible. This may prevent a user interface from being configured and/or adapted by either an application running on the portable device or by users. When coupled with the time-consuming requirement to memorize multiple key sequences and menu hierarchies, and the difficulty in activating a desired pushbutton, such inflexibility is frustrating to most users.

To avoid problems associated with pushbuttons and complex menu systems, portable electronic devices may use touch screen displays that detect user gestures on the touch screen and translate detected gestures into commands to be performed. However, user gestures may be imprecise; a particular gesture may only roughly correspond to a desired command. Other devices with touch screen displays, such as desktop computers with touch screen displays, also may have difficulties translating imprecise gestures into desired commands.

Accordingly, there is a need for touch-screen-display electronic devices with more transparent and intuitive user interfaces for translating imprecise user gestures into precise, intended commands that are easy to use, configure, and/or adapt. Such interfaces increase the effectiveness, efficiency and user satisfaction with portable multifunction devices.

SUMMARY

The above deficiencies and other problems associated with user interfaces for portable devices and touch screen devices are reduced or eliminated by the disclosed multifunction device. In some embodiments, the device is portable. In some embodiments, the device has a touch-sensitive display (also known as a "touch screen") with a graphical user interface (GUI), one or more processors, memory and one or more modules, programs or sets of instructions stored in the memory for performing multiple functions. In some embodiments, the user interacts with the GUI primarily through finger contacts and gestures on the touch-sensitive display. In some embodiments, the functions may include telephoning, video conferencing, e-mailing, instant messaging, blogging, digital photographing, digital videoeing, web browsing, digital music playing, and/or digital video playing. Instructions for performing these functions may be included in a computer readable storage medium or other computer program product configured for execution by one or more processors.

In an aspect of the invention, a computer-implemented method for use in conjunction with a computing device with a touch screen display comprises: detecting one or more finger contacts with the touch screen display, applying one or more heuristics to the one or more finger contacts to determine a command for the device, and processing the command. The one or more heuristics comprise: a heuristic for determining that the one or more finger contacts correspond to a one-dimensional vertical screen scrolling command, a heuristic for determining that the one or more finger contacts correspond to a two-dimensional screen translation command, and a heuristic for determining that the one or more finger contacts correspond to a command to transition from displaying a first item in a set of items to displaying a next item in the set of items.

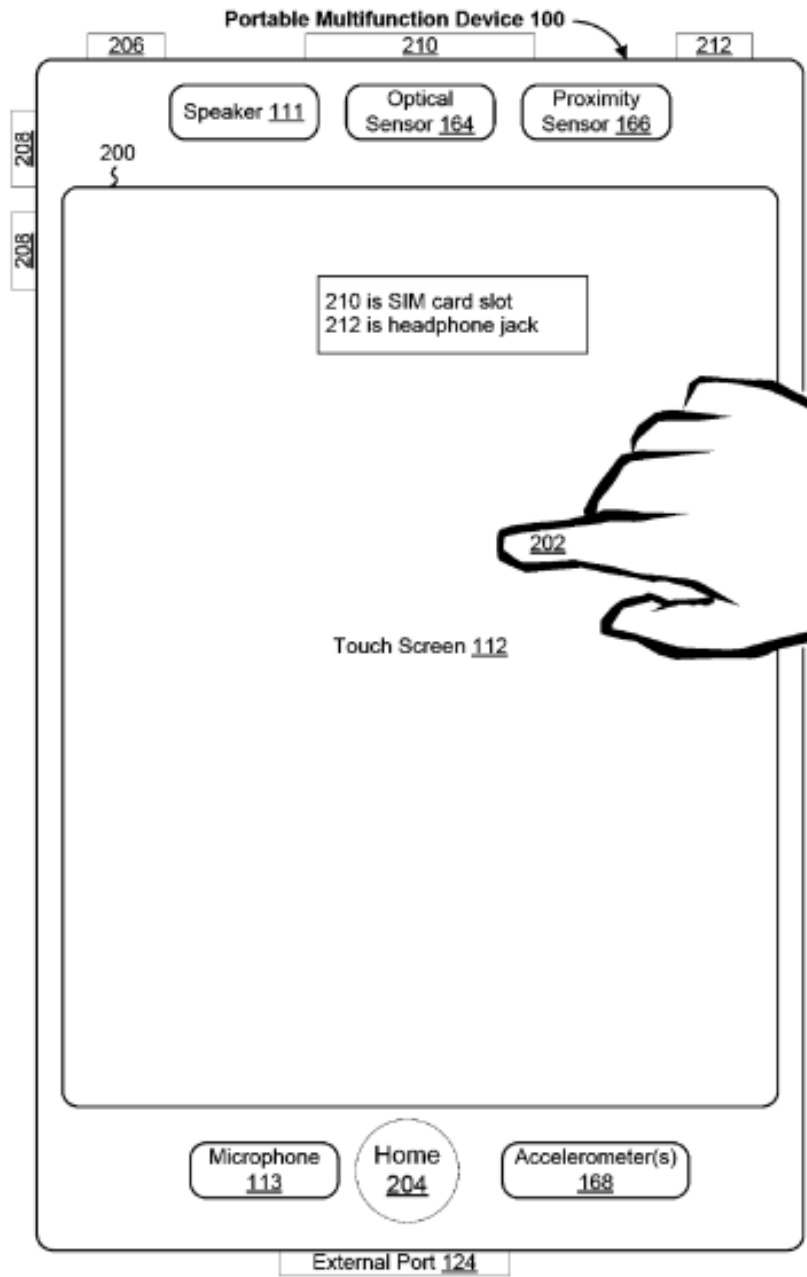


Figure 2

- Figure: everything is numbered
- No number re-used throughout document
- New items introduced in this figure start with “2” since Figure 2

sensor or other physical input/output device instead of a touchpad.

FIG. 2 illustrates a portable multifunction device 100 having a touch screen 112 in accordance with some embodiments. The touch screen may display one or more graphics within user interface (UI) 200. In this embodiment, as well as others described below, a user may select one or more of the graphics by making contact or touching the graphics, for example, with one or more fingers 202 (not drawn to scale in the figure). In some embodiments, selection of one or more graphics occurs when the user breaks contact with the one or more graphics. In some embodiments, the contact may include a gesture, such as one or more taps, one or more swipes (from left to right, right to left, upward and/or downward) and/or a rolling of a finger (from right to left, left to right, upward and/or downward) that has made contact with the device 100. In some embodiments, inadvertent contact with a graphic may not select the graphic. For example, a swipe gesture that sweeps over an application icon may not select the corresponding application when the gesture corresponding to selection is a tap.

The device 100 may also include one or more physical buttons, such as "home" or menu button 204. As described

Detailed description section: Describe / define all numbers in the figures

device is set to be on vibrate mode.

In some embodiments, a contact with the settings icon 6210 (FIG. 62C) is detected. In response to detecting the 25 contact, the list of settings is displayed (UI 6200A, FIG. 62A).

FIG. 62D illustrates exemplary user interfaces for displaying and adjusting wallpaper settings in accordance with some embodiments. In some embodiments, if a user selects to adjust wallpaper settings (e.g., by a finger tap anywhere in the 30 wallpaper row in UI 6200A (FIG. 62A)), UI 6200D (FIG. 62D) is displayed. A user may change the wallpaper displayed on the device by making the desired selections on UI 6200D.

FIG. 62E illustrates exemplary user interfaces for displaying and adjusting general settings in 35 some embodiments. In some embodiments, if a user selects to adjust general settings, UI 6200E (FIG. 62E) is displayed. General settings may include about, keyboard, network, touch, legal, and reset settings.

Detailed description:
multiple examples,
alternatives presented.

End of Detailed Description

- Example:
- The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.
- Goal: broaden the options covered by the detailed description



Exercise

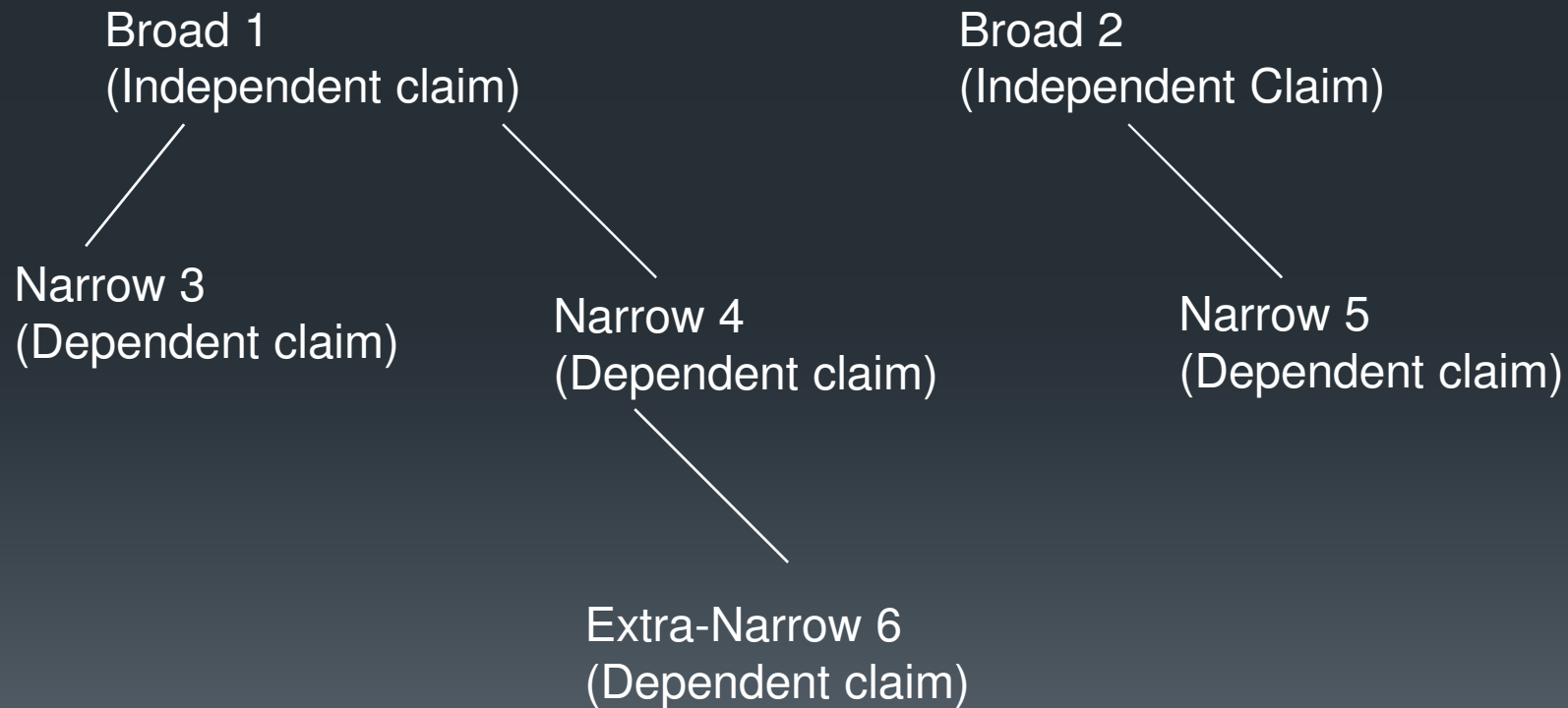
- Apple patent on touch-screen gesture commands
- Form small groups
- Make a point form:
 - Background
 - Summary of invention
 - Detailed description

Writing Claims

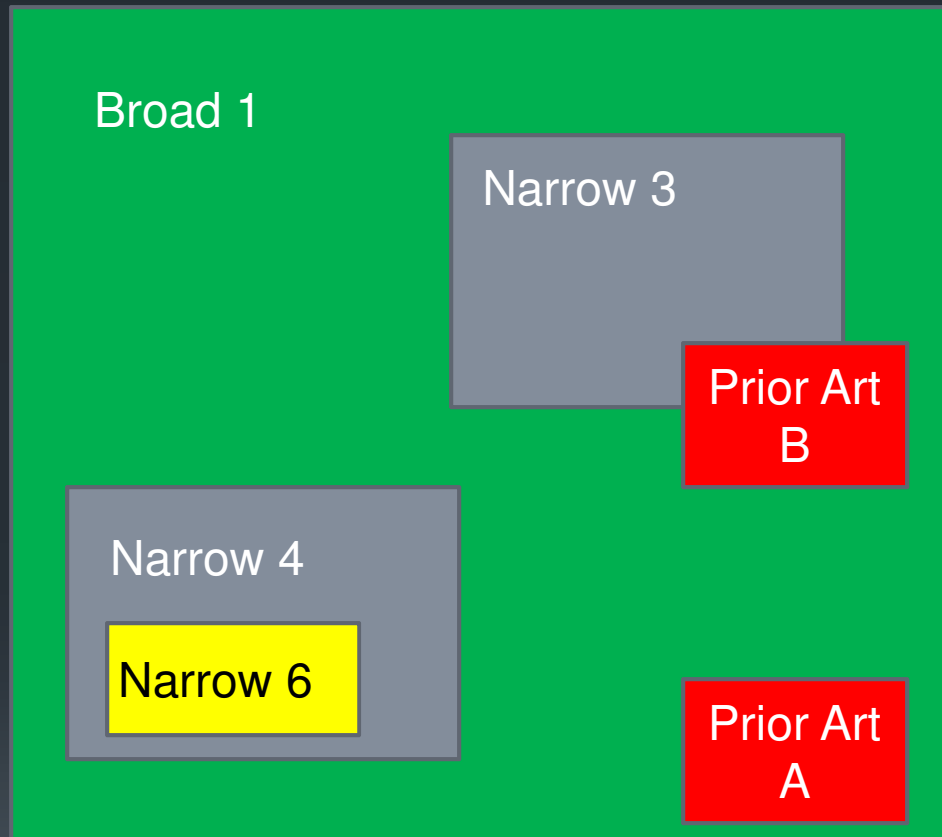
- The “payoff” of the patent
- Broad claims:
 - E.g. “touch-screen control of computer”
 - Cover any implementation of your idea
 - Very hard to design around
 - More valuable
 - Easier to invalidate by finding prior art
- Narrow claims:
 - E.g. “Thumb and forefinger pinching motion to zoom on a graphical map application on a handheld computing device with a multi-touch screen”
 - Easier to design around / less applicable
 - Harder to invalidate with prior art

Writing Claims

- Best:
 - Some broad and some narrow claims
 - “Claim tree”



Another View of Claims



Claim Writing

- Start with “What is claimed is”
- Each claim is numbered, and must be a single sentence!
- Can specialize earlier claims (dependent claims)

Claim Writing Example

What is claimed is:

1. A method for making a brick, comprising:
 - a) packing a composition including clay; and
 - b) heating the packed composition.
2. The method of claim 1, wherein the clay includes kaolin.
3. The method of claim 1, wherein the composition further includes lime.
4. The method of claim 1, wherein the packed composition is heated to a temperature of at least 1,000 deg. C.
5. The method of claim 4, further comprising:
 - c) holding the packed composition at 1,000 deg. C for at least an hour; and then
 - d) cooling the packed composition at a rate no greater than 50 deg. C per hour.

- 1 independent, 4 dependent claims
- *Source: Modern Times Legal*

Claim Costs

- Patent office trying to limit number of claims
- Extra fees for more than 20 claims in a patent
 - \$60 / claim after 20
 - \$250 / independent claim after 3



Exercise

- Apple patent on touch-screen gesture commands
- Form small groups
- Create a point-form claim tree
- Write two claims in detail

How To Write a Patent?

- Write background and detailed description of invention, in plain english
- Get a good lawyer (could do yourself, but slower)
 - Specializes in IP / patents
 - Has background in the area of technology in which you're working!
 - Often will have undergrad degree in engineering field
 - I used a Toronto lawyer once → non-expert, very inefficient
 - SF/Illinois lawyers specializing in CAD / chips after → much more efficient

How To Write?

- Lawyer
 - He/she will discuss invention with you, take notes
 - I find writing a good detailed description helps
 - More efficient than verbally describing and correcting later
 - Include (regular) figures
 - Lawyer can write abstract, put numbers on figures, translate to legalize
 - Review the lawyer's work and correct
- Claims
 - Often useful to brainstorm / give outline to lawyer
 - Lawyers good at turning into full claim tree
 - Always review the claims in detail
 - Anything missing?
 - Covering related industries in broadest claims?

Filing & Examination

- Sign a form saying you have disclosed all relevant prior art to patent office
 - Your background should have referenced prior work you knew about
 - Invention description should say how you're different
 - Illegal to knowingly hide prior work
 - But OK to simply be unaware of it
- A year or so later, patent examiner will challenge your claims
 - List one or more patents and say they cover some or all of your claims
 - You must refute (show how you are different), or drop the claims
 - Sometimes prior art way off base → great! Easy to refute
 - Sometimes patent office found good prior art → may lose some claims
- Usually ~3 years from filing to patent issue



Software Patent Example

- Fung, Betz and Chow, Method and apparatus for utilizing long-path and short-path timing constraints in an electronic-design-automation tool for routing

(54) **METHOD AND APPARATUS FOR UTILIZING LONG-PATH AND SHORT-PATH TIMING CONSTRAINTS IN AN ELECTRONIC-DESIGN-AUTOMATION TOOL FOR ROUTING**

(75) Inventors: **Ryan Fung**, Mississauga (CA); **Vaughn Betz**, Toronto (CA); **William Chow**, North York (CA)

(73) Assignee: **Altera Corporation**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 290 days.

(21) Appl. No.: **10/774,857**

(22) Filed: **Feb. 9, 2004**

(51) **Int. Cl.**
G06F 17/50 (2006.01)

(52) **U.S. Cl.** **716/6; 716/9**

(58) **Field of Classification Search** **716/1-6, 716/8-12, 18**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,237,514 A	8/1993	Curtin	
5,521,837 A	5/1996	Frankle et al.	
5,541,849 A	7/1996	Rostoker et al.	
5,649,167 A *	7/1997	Chen et al.	703/23
5,659,484 A	8/1997	Bennett et al.	
5,764,528 A *	6/1998	Nakamura	716/6
6,286,126 B1 *	9/2001	Raghavan et al.	716/6
6,349,402 B1 *	2/2002	Lin	716/2
6,578,183 B2 *	6/2003	Cheong et al.	716/7
6,701,505 B1 *	3/2004	Srinivasan	716/10

6,701,506 B1 *	3/2004	Srinivasan et al.	716/10
6,708,139 B2	3/2004	Rearick et al.	
6,763,506 B1 *	7/2004	Betz et al.	716/6
6,836,753 B1 *	12/2004	Silve	703/2
6,871,336 B1 *	3/2005	Anderson	716/9
6,973,632 B1 *	12/2005	Brahme et al.	716/6
7,062,743 B2 *	6/2006	Kahng et al.	716/13
7,076,758 B1 *	7/2006	Srinivasan et al.	716/11
2001/0049814 A1 *	12/2001	Matsumoto et al.	716/10
2002/0073389 A1 *	6/2002	Elboim et al.	716/6
2003/0005398 A1	1/2003	Cho et al.	
2003/0051222 A1 *	3/2003	Williams et al.	716/12
2003/0088842 A1 *	5/2003	Cirit	716/9
2004/0230921 A1	11/2004	Hathaway et al.	
2004/0243964 A1	12/2004	McElvain et al.	
2005/0039156 A1	2/2005	Cathoor et al.	
2005/0132318 A1	6/2005	Kidd et al.	
2005/0138578 A1	6/2005	Alpert et al.	
2005/0251775 A1	11/2005	Wood	

OTHER PUBLICATIONS

NN9107410, "Linear Algorithm for Distributing Slack So That All Nets of a Design Have a Zero Slack Pin", IBM Technical Disclosure Bulletin, vol. 34, No. 2, Jul. 1991, pp. 410-414.
Mathur et al., "Timing-Driven Placement for Regular Architectures", IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, vol. 16, No. 6, Jun. 1997, pp. 597-608.

* cited by examiner

Primary Examiner—Jack Chiang

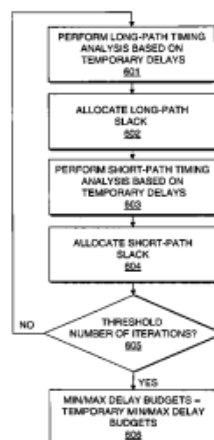
Assistant Examiner—Binh Tat

(74) *Attorney, Agent, or Firm*—L. Cho

(57) **ABSTRACT**

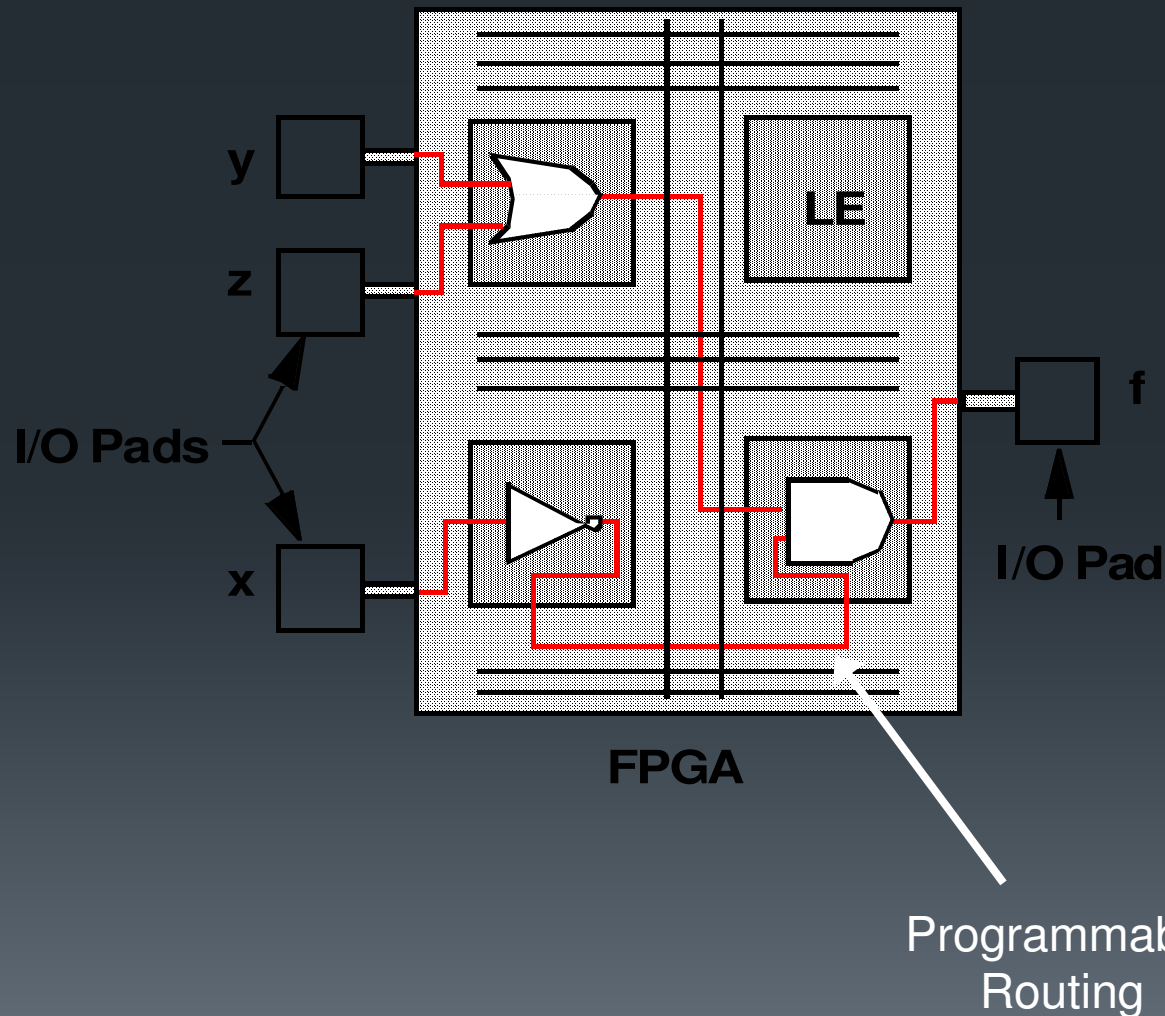
A method for designing a system includes determining minimum and maximum delay budgets for connections. Routing resources are selected for connections in response to the minimum and maximum delay budgets.

60 Claims, 18 Drawing Sheets



Background of Invention

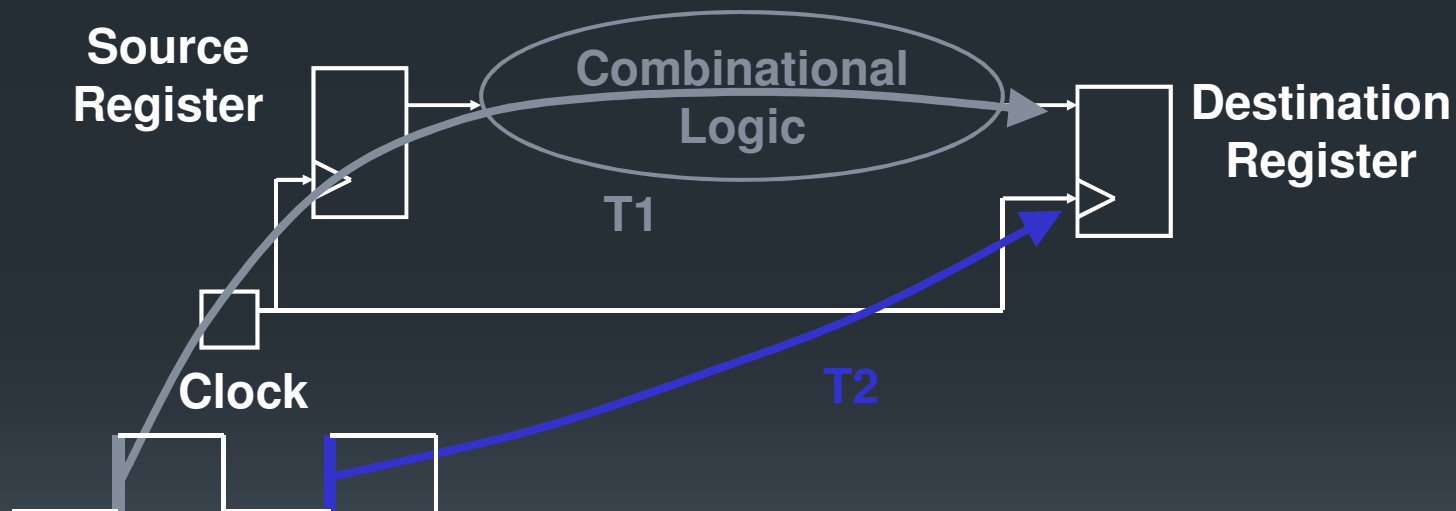
- FPGA Routing: choose wires/switches to connect every block output to block input needed by circuit



Long-Path Timing (Max Freq.)

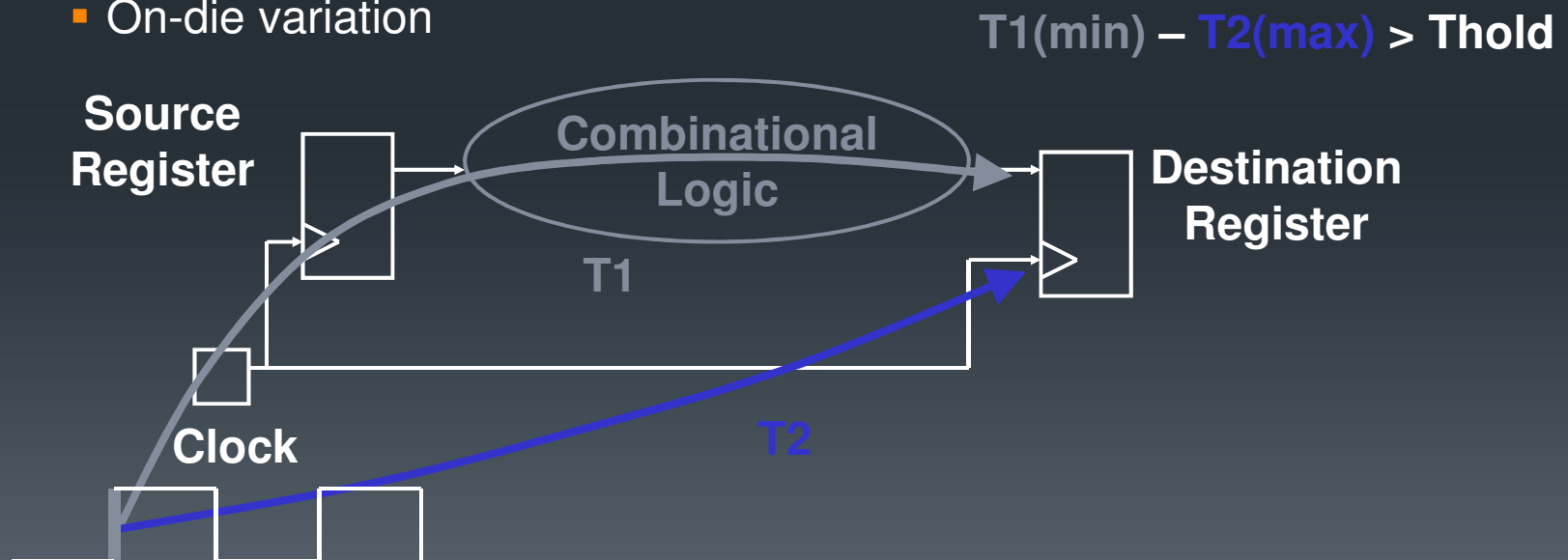
- Long path timing

$$T1(\max) - T2(\min) < T_{\text{cycle}}$$



Short Path Timing (Hold Time)

- Required to operate at *any* speed
- Violations becoming more common
 - Complex clocking
 - Complex I/O interfaces
 - On-die variation





Router Timing Optimization

- Use routing to solve short path timing
 - Slow down paths that are too fast
 - Integrate with long path optimization → protect paths that will limit maximum frequency
- Complex algorithm
- Never automated in any CAD tool to our knowledge
- And certainly not for any FPGAs

Claim Tree?



1. General algorithm (independent claim)
 - As broad as we can make it, **without infringing prior art we know about**
2. More specific variants of the algorithm (dependent claims)
 - A whole bunch of dependent claims
3. Using the algorithm in a Programmable Logic Device (PLD) (dependent claim)
4. Claims where the various algorithms are stored in a “machine-readable medium” and implemented on a processor
 - Typical to have this in software patents
 - Method on a computer more specific than a general algorithm
 - 1 independent claim (copy of #1)
 - Several dependent claims specializing algorithm (copy of #2)
 - Dependent claim specializing to programmable logic device (copy of #3)

Claim Tree



1. A method for designing a system, comprising: determining minimum and maximum delay budgets for connections along a path by finding a set of connection delays that satisfy a short-path timing constraint for the path, which indicates that the delay from one end of the path to an other end must be no smaller than a first value, and a long-path timing constraints for the path, which indicates that the delay from one end of the path to the other end must be no larger than a second value; and selecting routing resources for implementing the connections in the system in response to the minimum and maximum delay budgets.
2. The method of claim 1, wherein determining minimum and maximum delay budgets comprises considering lower and upper delay limits of routed connections based on potential routing possibilities.
3. The method of claim 2, wherein, lower delay limits of the routed connections are determined based on an initial selection of routing resources that minimizes connection delays and ignores shorted signals.
4. The method of claim 1, wherein determining minimum and maximum delay budgets comprises starting with initial estimates of final routed delay.

...

Claim Tree



41. The method of claim 1, wherein the routing resources are programmable logic device routing resources.

42. A machine-readable medium having stored thereon sequences of instructions, the sequences of instructions including instructions which, when executed by a processor, causes the processor to perform: determining minimum and maximum delay budgets for connections along a path by finding a set of connection delays that satisfy a short-path timing constraint for the path, which indicates that a delay from one end of the path to an other end must be no smaller than a first value, and a long-path timing constraint for the path, which indicates that a delay from one end of the path to an other end must be no larger than a second value; and selecting routing resources for implementing the connections in the system in response to the minimum and maximum delay budgets.

43. The machine-readable medium of claim 42, wherein determining minimum and maximum delay budgets comprises considering lower and upper delay limits of routed connections based on potential routing possibilities.

... (70 total claims)



Thank You!

Links



Apple gesture interface:

<http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&p=4&u=%2Fnetacgi%2FPTO%2Fsearch-bool.html&r=191&f=G&l=50&co1=AND&d=PTXT&s1=Jobs.INNM.&s2=Apple.ASNM.&OS=IN/Jobs+AND+AN/Apple&RS=IN/Jobs+AND+AN/Apple>