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## Case Studies

CSE 403, Winter 2005  
Software Engineering

<http://www.cs.washington.edu/education/courses/403/05wi/>

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## Readings and References

- *Introduction to the 5ESS Switching System*, Martersteck, Spencer
  - » *AT&T Technical Journal*, v 64 n 6, July-August 1985
- *Parallel Changes in Large Scale Software Development: An Observational Case Study*, Perry, Siy, Votta
  - » <http://citeseer.nj.nec.com/462.html>
- *Challenges in Evolving a Large Scale Software Product*, Siy, Perry
  - » <http://citeseer.nj.nec.com/siy98challenges.html>
- *Boeing's 777 Systems Integration Lab*, Lansdaal, Lewis
  - » *IEEE Instrumentation & Measurement Magazine*, V 3, issue: 3, Sep 2000
- *Boeing 777 Flies on 99.9% Ada*
  - » <http://www.adaic.org/atwork/boeing.html>
- *Software Development for the Boeing 777*, Pehrson
  - » <http://www.stsc.hill.af.mil/crosstalk/1996/01/Boein777.asp>

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## Readings and References

- *Tackling TB with cellphone technology*, Janet Heard
  - » *The Sunday Times*, Cape Town, South Africa
  - » <http://www.sundaytimes.co.za/2002/06/02/news/cape/nct01.asp>
- *The Compliance Service uses SMS technology for TB treatment*
  - » [http://www.bridges.org/iicd\\_casestudies/compliance/index.html](http://www.bridges.org/iicd_casestudies/compliance/index.html)
- *Simpill, Real Time Compliance Management*
  - » <http://www.compliance.za.net/>
- **The Bandwidth Barn**
  - » “The barn is a unique incubation model where the stability of anchor tenants is coupled with a dynamic and evolving set of incubytes. We are an open-platform model of incubation... the linux of incubators.”
  - » <http://www.bandwidthbarn.org/>

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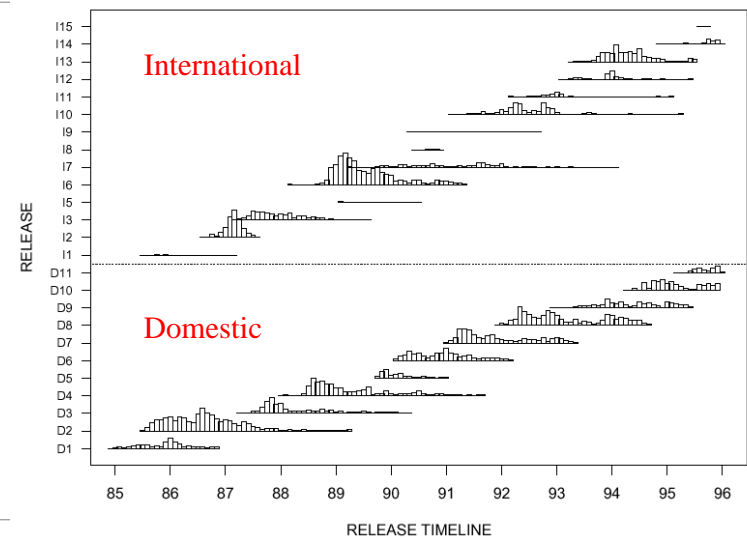
## 5ESS Telephone Switching System



## 5ESS Telephone Switching System

- Large real-time system for telephone switching
- More than 10 Million lines of code
  - » divided into 50 subsystems
  - » more than 3000 developers
  - » runs on Unix, written in C
- Worldwide application and sales (and doodads)
  - » “The Lucent 5ESS® switch provides an extensive portfolio of services ... These services will generate additional revenue and increase customer satisfaction.”

DELTAS PER MONTH



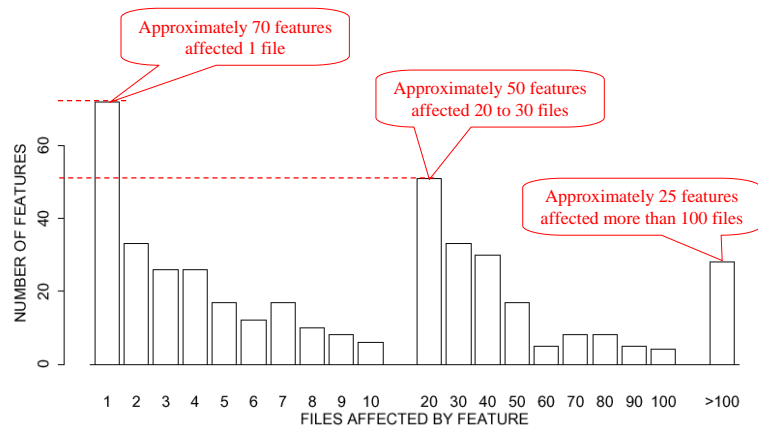
## Change implementation

- Extensive change management process
  - » Initial Modification Request, Modification request
- Coding Process
  - » Make a private copy of necessary files
  - » Try out the changes within private copy
  - » Commit the changes as deltas
  - » Put private copy through code inspection, unit test
  - » Submit for load integration, feature and regression testing

## Concurrency

- Concurrent release activity is high
  - » 3-4 major releases in work at the same time
- Concurrent change activity is high
  - » some files being changed for 10 concurrent MRs
- Nearly 30% of MRs for release discarded
  - » duplicate problems already fixed
  - » unnecessary fixes requested by developers who misunderstood system requirements

## Open files per feature implementation



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9

## Build cycle

- Central build team
  - » announce freeze date, MRs submitted
  - » depending on errors, build takes 1 to 7 weeks
- Distribute and bring up the new load
  - » test lab environment changes with build
  - » almost 20% of faults in test environment or setup
- Feature and Regression testing
  - » if test fails immediately, significant time has been lost in doing all the build and setup

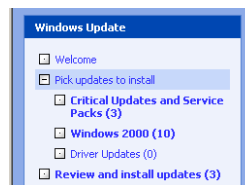
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10

## Managing Installed Changes

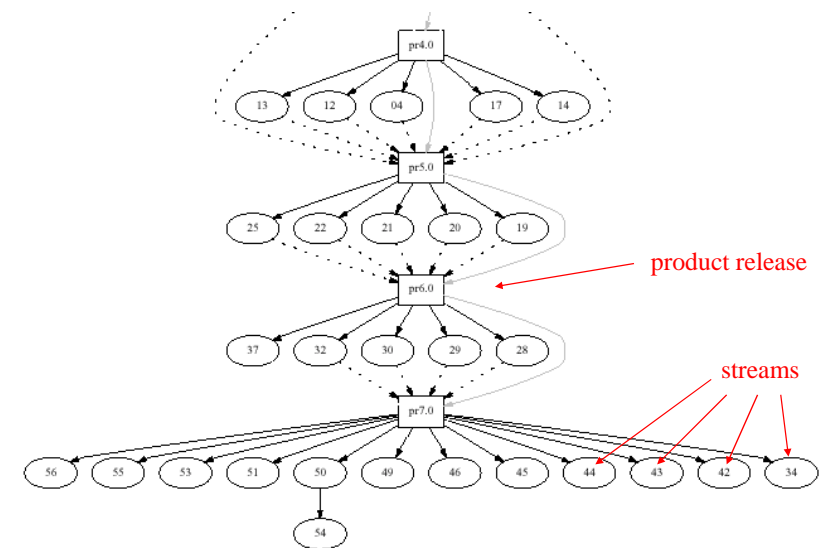
- Product releases are the “standard product”
- Software updates provided between releases
  - » do you apply every WinOS update?
  - » should you apply every update?
  - » Telcos don't want to
- 5ESS is maintained as streams
  - » major release plus selected updates
  - » about 100 concurrent streams being maintained



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11



Release I12 streams genealogy.

## Issues in parallel evolution

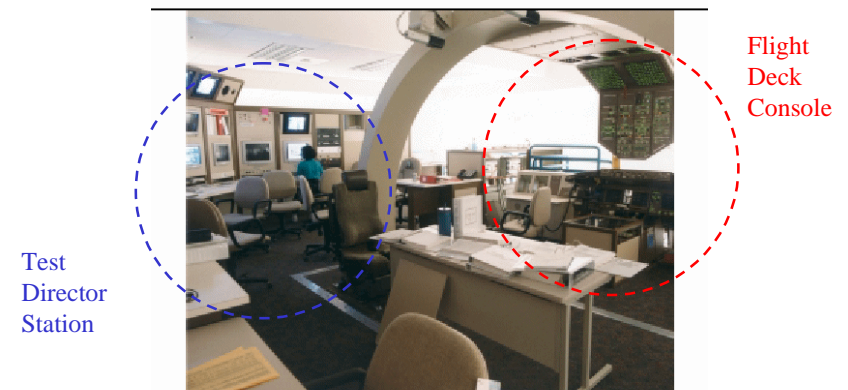
- Costs of build problems: backtracking to source, lost setup/test effort, lost calendar time
- Tradeoff between benefits of frequent builds and costs of setup and test
- Ensuring change compatibility with all versions
- Propagating change to all versions that need it
- Feature migration across product lines and streams



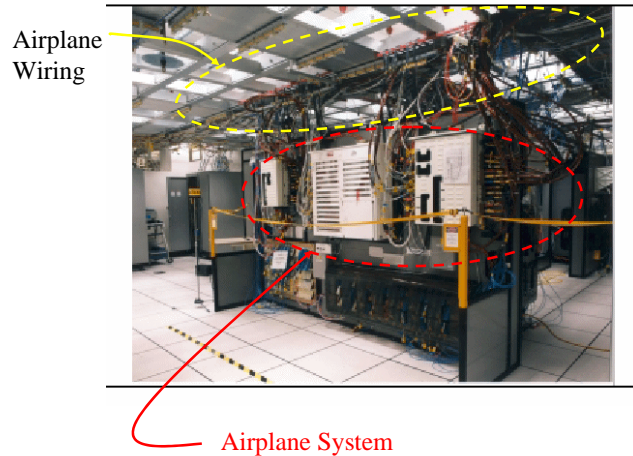
## Boeing 777 Systems Integration Lab

- Modern airplanes are flying networks of integrated computers
  - » 100 major line replaceable units, plus 300 minor
  - » 15 ARINC-629 multiplexed data buses
  - » 169 ARINC-429 dedicated data buses
- Integration test system to model airplane and dynamic environment
  - » integrated “flight” through simulated conditions
  - » dynamic power system operating conditions

## SIL Flight Deck



## SIL Electrical / Equipment Bay



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17

## Systems

- Airplane systems
  - » total approximately 2.5 M source lines of code
    - power system: 80,000 SLOC
    - info mgmt: 613,000 SLOC, 550 developers
- Lab systems
  - » 500,000 SLOC for simulation and test
  - » simulation host, I/O nodes, I/O subnodes
  - » 4+ supervisors, 170 engineers/technical designers
    - 1,000,000 labor hours for design and build

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18

## Benefits of Development and Testing

- Development
  - » independent review and use of design information
  - » interface specifications, pin-out differences, etc
- Testing
  - » System-level tests - verify operation in context
  - » Airplane-level test - validate all-up operation
  - » Manufacturing and Customer service tests - validate factory operations, maintenance

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19

## Results

- Extensive test program
  - » before 1<sup>st</sup> flight: 2500 hours including 550 flight hrs
  - » total: 6500 hours including 1700 flight hrs
  - » per hour cost approximately 1/3 of airplane
- Highlighted or identified many problems
  - » 5,000 problem reports
  - » approximately 2/3 were actual airplane problems
- Lab was mothballed then dismantled after cert

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20

## SMS technology for TB patients

Working in the TB capital of the world, Dr Green sends daily automated SMS messages to patients with cellphones to remind them to take their life-saving pills - - five times a week for six months



## Who wants it?

- Cape Town, South Africa, has one of the world's highest incidences of TB
  - » poverty and cold wet weather
- TB patients must strictly follow a difficult drug regime -- four tablets five times a week for six months
- TB patients often do not take their medication simply because they forget

## What does it do for us? How?

- Dr. Green uses SMS (Short Messaging Service) to alert patients to take their medication
- Healthcare professional were skeptical whether the uptake of cell phone technology was high enough to justify the project
- But, at one clinic where the pilot study was conducted, 71% of TB patients had access to a cell phone. At another, 30% had access.

## Who'll support it?

- Dr. Green twisted the arm of City of Cape Town health director Ivan Toms, who authorized funding for the SMSs, at a cost of R11.80 a patient a month.
- On-Cue provides a system which automates the construction and delivery of SMSs (text messages) to recipients' cellphones at predetermined times.
  - » <http://www.compliance.za.net/products.html>



## Modify the product as needed

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- "Take your Rifafour now."
- When patients complained about the boring message, Dr. Green sent them a variety of alerts, including jokes and lifestyle tips
- He now has as database of over 800 messages that he changes on a daily basis. Of the 138 patients involved in the pilot, there was only one treatment failure.

## Is it scalable?

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- The World Health Organization has cited the project as an example of "international best practice"
- The City Council of Cape Town has decided to extend the pilot project to other City clinics where the cell phone ownership of patients is high
- The South African Government is considering the technology for nationwide use



- 7 Habits of Highly Effective ICT-Enabled Development Initiatives
  - » Implement and disseminate best practice
  - » Ensure ownership, get local buy-in, find a champion
  - » Do a needs assessment
  - » Set concrete goals and take small achievable steps
  - » Critically evaluate efforts, report back to clients and supporters, and adapt as needed
  - » Address key external challenges
  - » Make it sustainable

## Is it sustainable?

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- The Compliance Service is based at the UUNET Bandwidth Barn which provides small IT businesses with affordable office rentals, shared office facilities, and reduced Internet connectivity costs.
  - » <http://www.bandwidthbarn.org/>
- He deliberately kept the price of his service low so that more people can use and benefit from the technology.