Universities at the Edge

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Agenda

- Higher Education and Research Pressures
  - What's the business problem we are trying to solve ?
- Consequences for ICT
  - And in particular, **networked infrastructures**

Issues Confronting Universities Worldwide

- To sustain *relevance* for successive generations of students anxious to gain and extend new knowledge and practice across a lifetime of work, personal growth and social and civic participation
- To build *resilience* into the teaching, research, financial, technical and human systems on which they have to draw to achieve their mission during rapid and turbulent change
- To nurture *reputation* as the foundation for a compelling position in a crowded and competitive market for higher learning and professional knowledge

The Globalisation Revolution – No Boundaries

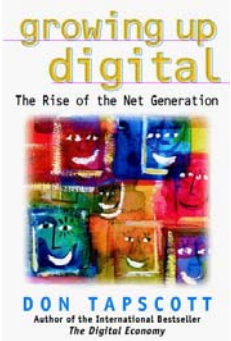
- One **BILLION** people have Internet access (late 2005)
- Competition for education increasingly international
- Growing demand for international experience from both companies and students to meet the needs of commercial globalisation

A Consumer Revolution – Users as Innovators

- Innovation is no longer driven by the military or research institutions … or even universities
- Innovation is appearing at the **consumer level**, and through **social networking of consumers**

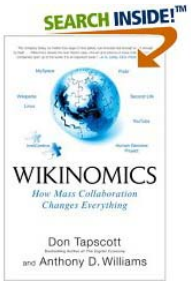
A Demographic Revolution – The Net Generation

- The first generation to grow up immersed in digital technologies is coming of age and emerging as a major force in today's world – a generation that will demand increasingly speedy, responsive and customisable services
- Multi-modal experiences are commonplace



A Social Revolution – Social Networking

- With 85 percent of university students on Facebook and MySpace growing at 300,000 new registrants per day, new venues for structured and unstructured online collaboration and social networking are commonplace
- Social vs. Cartesian learning



The Green Revolution – The Big, Long Term Picture

- Triple Bottom Line – **environmental, social and commercial**
- Green practises are becoming mainstream
  - Re-Evaluation of work flow and business practises
- Investments in infrastructure are being evaluated on their "smartness" to manage energy use better
  - Smart buildings
- Increasingly focus on how to minimise travel and office space usage, but maintain (or improve) stakeholder "touch"

Research and eResearch

- Research is increasingly collaborative

  Multiple departments, institutions, countries, teams of people

- *The term 'e-Research' encapsulates research activities that use a spectrum of advanced ICT capabilities and embraces new research methodologies emerging from increasing access to:*

  Broadband communications networks, research instruments and facilities, sensor networks and data repositories;

  Software and infrastructure services that enable secure connectivity and interoperability;

  *Application tools that encompass discipline-specific tools and interaction tools.**

*** DEST, http://www.dest.gov.au/sectors/research_sector/policies_issues_reviews/key_issues/e_research_consult/**

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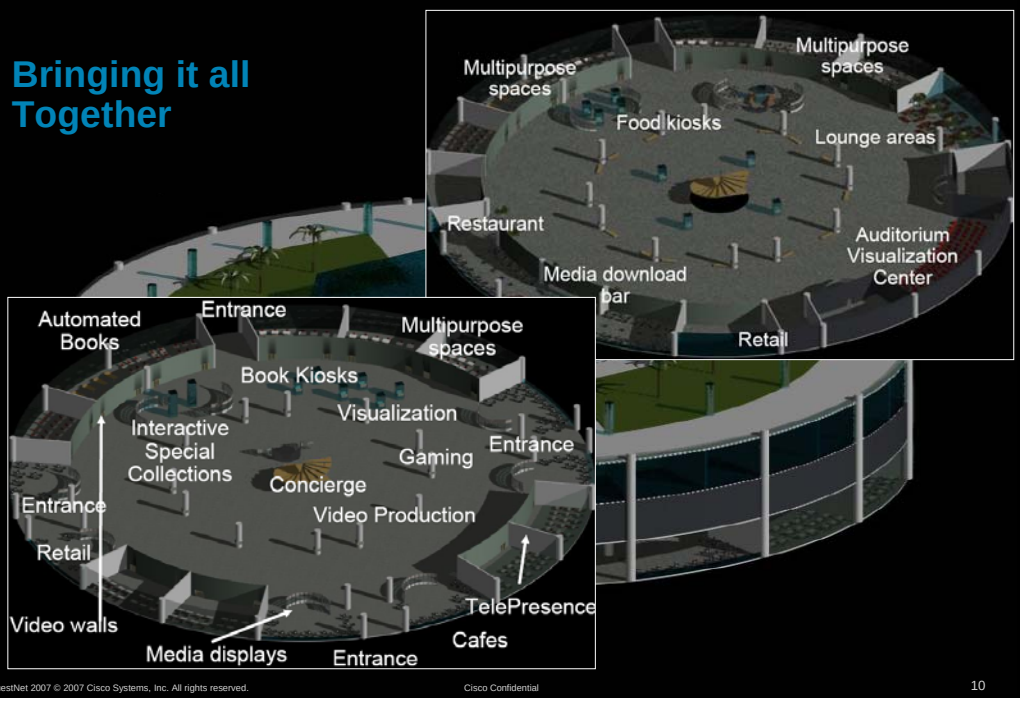
Bringing it all Together



Consequences for ICT

Rate of Change Challenges Enterprises

IT Caught in the Middle

- Business Relevance ... Real and Perceived

Enterprise Demands

- Compliance
- DR Strategies
- Security
- HA
- QoS
- Backup and Recovery

Student & Staff Demands

"I want Facebook for the Enterprise..."

"I'm going to do it whether you support it or not..."

"Why can't I access …"

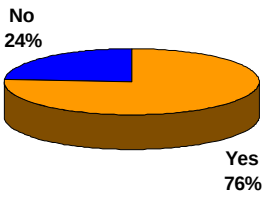
Doing More With Less

- Efficiency
- Effectiveness
- Productivity

Effectiveness – Productivity

In Praise Of IT

Because of technology, do workers put in the same hours but get more done ?



DATA: INFORMATIONWEEK RESEARCH PRODUCTIVITY STUDY OF 300 IT AND BUSINESS EXECUTIVES

Information Week Research

"US productivity growth, fuelled by ICT, is sustainable and will continue"

Efficiency – Standardisation, Centralisation, Outsourcing

- Central themes of Enterprise ICT efficiency are standardisation and/or centralisation and/or outsourcing
- University environment is not obviously amenable to all of the above
  - Diverse user communities (students, general staff, academics)
  - User communities are themselves very diverse, often very skilled
  - Some history of departmental autonomy
  - High end users and ICT requirements are VERY high end and unique
  - Particularly unattractive to traditional out-sourcing

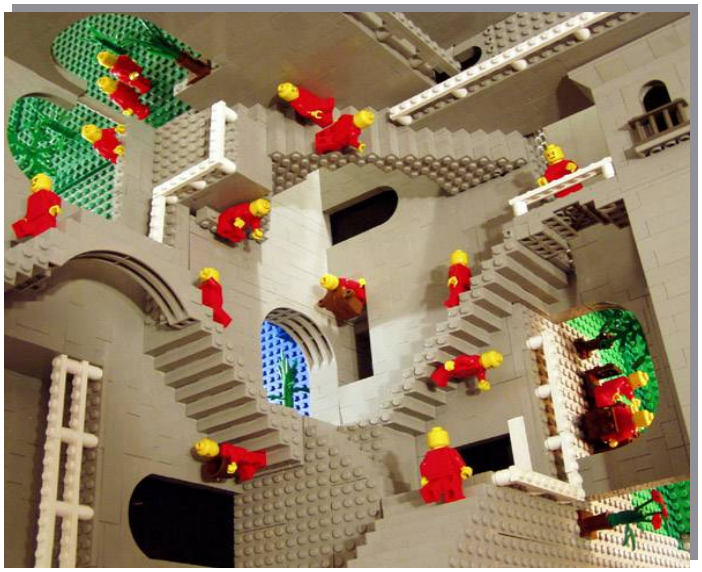
User Community Characteristics

- Administration
  - Similar profile to a “typical enterprise network user”
- Undergraduate
  - Wants to stream music, download torrents, watch a video all while accessing learning materials on a wireless laptop with no security
- Academic staff
  - Want to be able to deliver courses however it suits them (overhead, PowerPoint, HD video, blog, wiki)
  - Want access to information to be open to everyone (except people who aren’t supposed to see it …)
- Post Graduate/ Research
  - Fast unfiltered access to anyone, anywhere in the world …
    … when can I have that 100Gbps link to Vladivostok ?

So what does this make the network look like ?

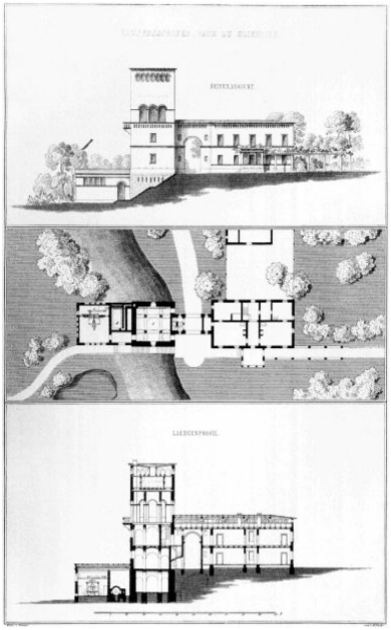
- High speed non-blocking core
- Deep packet inspection at the Internet access
- Rich and granular QoS everywhere
- Rate limiting for unknown traffic profiles at the edge
- Research networks with 10Gbps+ to Internet2 (no filtering)
- Enterprise grade security for student and financial systems
- Campus wide mobility
- Access for visiting staff/academics
- Non-repudiation of traffic flows
- Peer to Peer Traffic Management
- Identity awareness and Network Access Control
- Video streaming and multicast
- 9216 byte Frames
- EoMPLSoGRE
- IPv6
- …

Complexity



Architecture

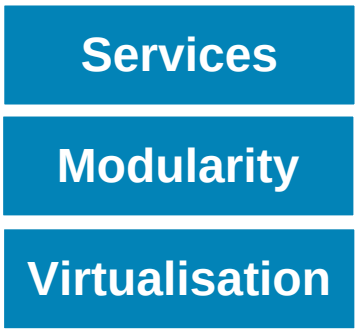
- An architecture is the fundamental organisation of a system, the **relationships** between its **components** and the environment, and the **principles** governing its design and evolution
  - Components
  - Relationships
  - Principles



Design for a gardener's cottage and engine house in the grounds of a castle. Ludwig Persius, Berlin, 1836.

Principles

- Build a single infrastructure that is capable of supporting large scale and diverse requirements, by …
- Structuring the infrastructure to support change, minimise risk, and maximise reliability and consistency of …
- Services supplied to end users across infrastructure



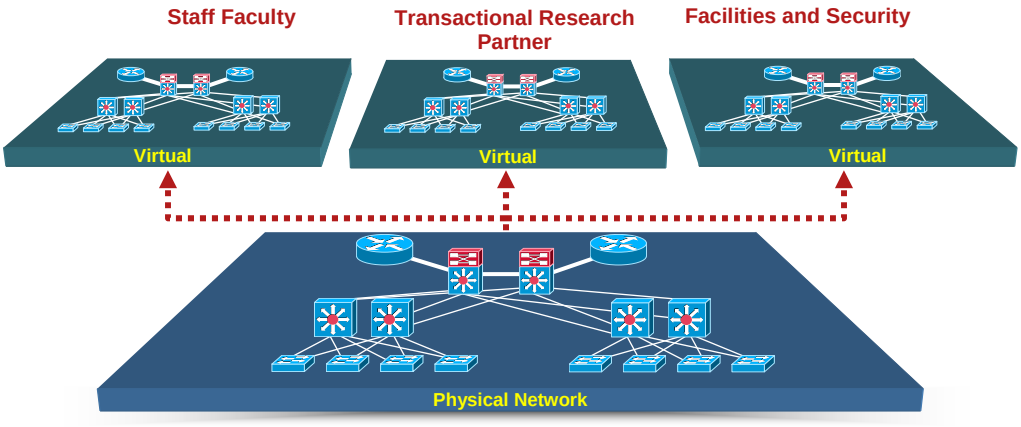
University = Enterprise + Service Provider

- **Service Provider**
  - Want to build a single infrastructure for multiple uses
  - Need to scale to tens of thousands of "subscribers*"
  - Lots of "subscriber* churn"
  - "Subscribers*" are aggressive, demanding and hard to control
  - Need to provide large scale highly granular billing
  - "Subscribers" have their own services innovation agenda based around their own end points
  - Huge consumer of commodity Internet
- **Enterprise**
  - Want an infrastructure that optimises staff/academic outcomes and productivity
  - Need to scale to thousands of users
  - Strong accountability requirements
  - Range of unique ICT needs
  - Very rich set of services based around university supplied end points and spaces
  - Need very rich set of networked services over and above commodity Internet

*Students

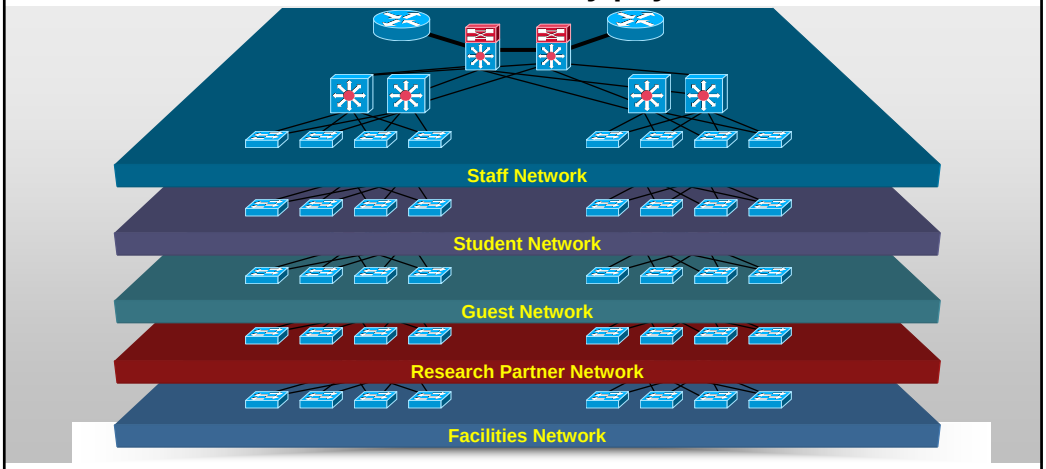
What is Network Virtualisation?

- Virtualisation: 1 to Many
- One network supports many virtual networks



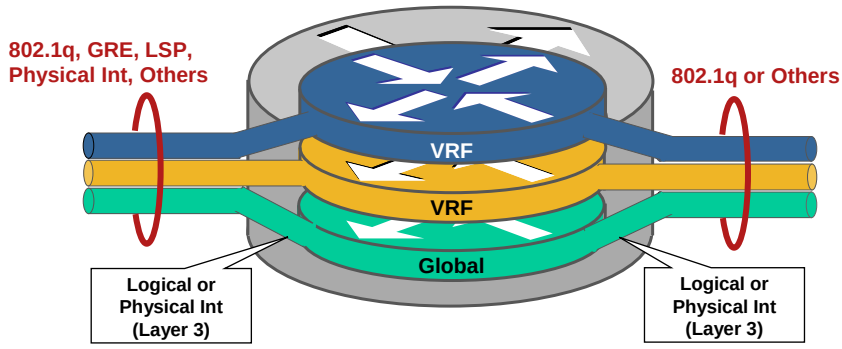
What Is Network Virtualisation?

- **Virtualisation: Many to 1**
- **One network consolidates many physical networks**

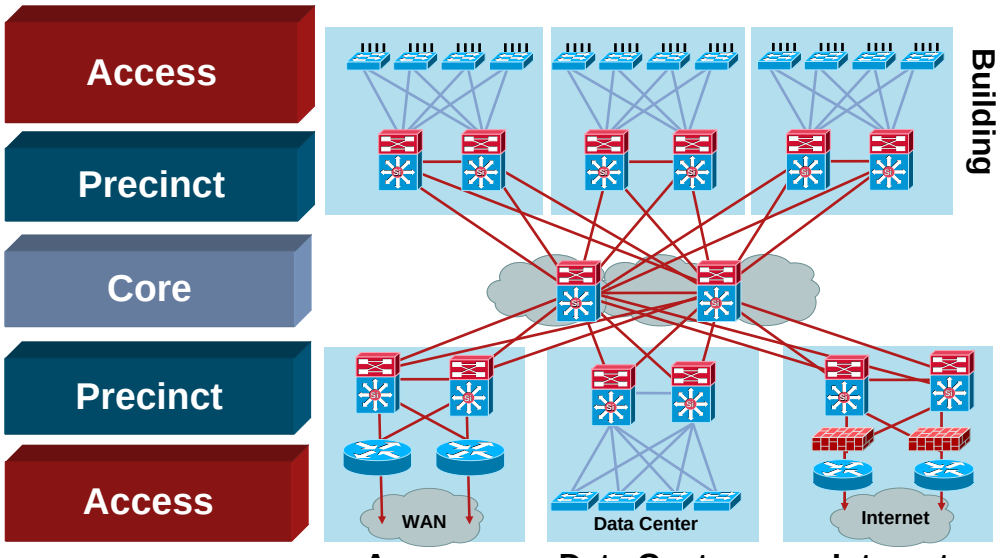


Virtualised Network Devices

- Switch virtualisation – VLANs
- Router virtualisation – Virtual Routing/Forwarding (VRFs)
- Optical virtualisation – Lambdas
- End point (**Data Centre**) virtualisation



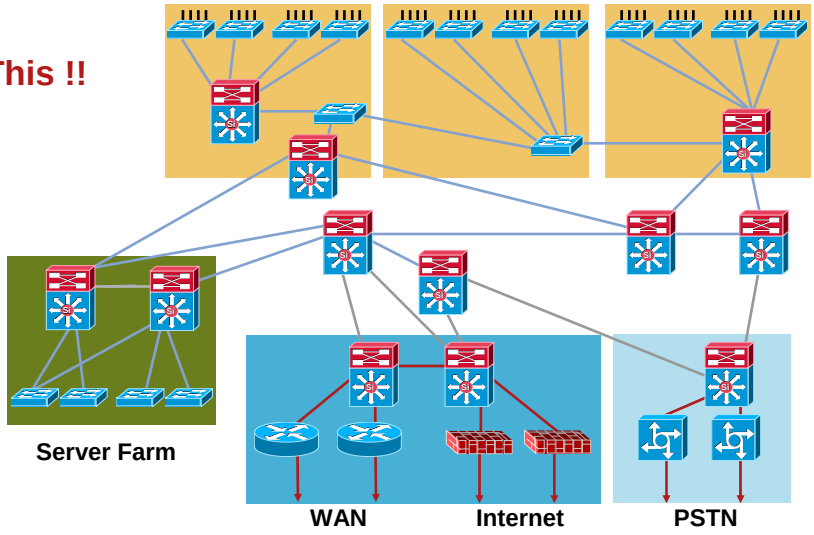
Modular Campus Design – Structure, Modularity, and Hierarchy



Hierarchical Campus Network

Structure, Modularity and Hierarchy

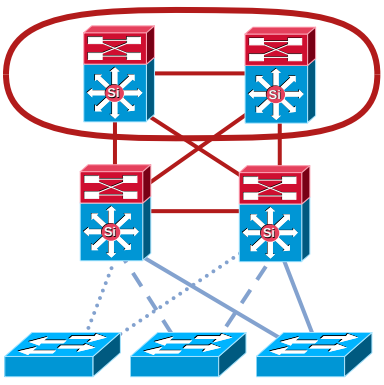
Not This !!



Core Module

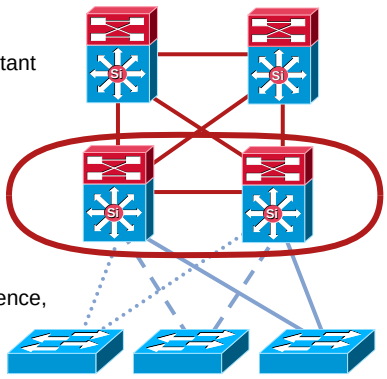
Scalability, High Availability, and Fast Convergence

- Backbone for the network - connects network building blocks
- Less is more in the core
- Keep the design technology-independent
- High-Speed (10Gbps+)
- Routed



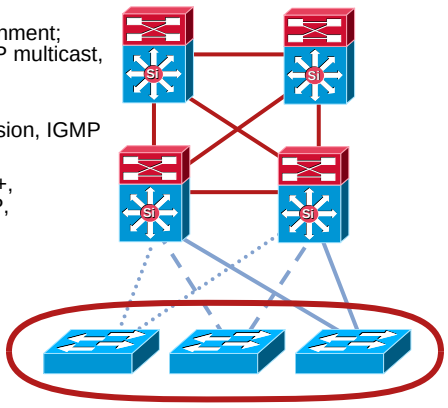
Precinct/Building Module
Policy, Convergence, QoS, and High Availability

- Availability, load balancing, QoS and provisioning are the important considerations at this layer
- Aggregates wiring closets (access layer) and uplinks to core
- Protects core from high density peering and problems in access layer
- Route summarization, fast convergence, redundant path load sharing
- HSRP or GLBP to provide first hop redundancy

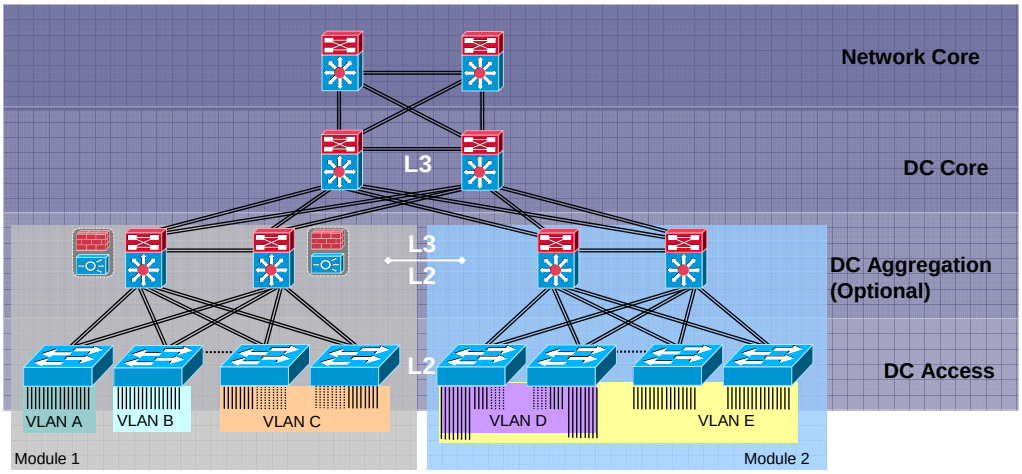


Access Module
Feature Rich Environment

- It's not just about connectivity
- Layer 2/Layer 3 feature rich environment; convergence, HA, security, QoS, IP multicast, etc.
- Intelligent network services: QoS, trust boundary, broadcast suppression, IGMP snooping
- Intelligent network services: PVST+, Rapid PVST+, EIGRP, OSPF, DTP, PAgP/LACP, UDLD, FlexLink, etc
- Cisco Catalyst integrated security features IBNS (802.1x), (CISF): port security, DHCP snooping, DAI, IPSG, etc.
- Automatic phone discovery, conditional trust boundary, power over Ethernet, auxiliary VLAN, etc.
- Spanning tree toolkit: Portfast, UplinkFast, BackboneFast, LoopGuard, BPDUGuard, BPDUFilter, RootGuard, etc.



Data Center Module



Services – Within and Between Layers

- Unified communications
- Wireless access services
- Guest access service
- Peer to peer application management
- Data centre infrastructure

- Anything that makes a virtual instance unique and fit for purpose

The Technology and Architecture for the Human Network

On the Human Network people decide what's possible