Devolved Control
of
ATM Networks

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Why ATM?

1. The ATM Compromise
   Carries circuits and packets equally badly.
   Win on economy of scale.

2. The ATM Advantage
   Communication is not just best effort packets and cast iron circuits.

3. ATM Flexibility
   Who knows what applications will be in 2015? Deploy something that will cope.

We've sorted out the easy part of ATM
- Can do multiple services
- with QoS (sort of)

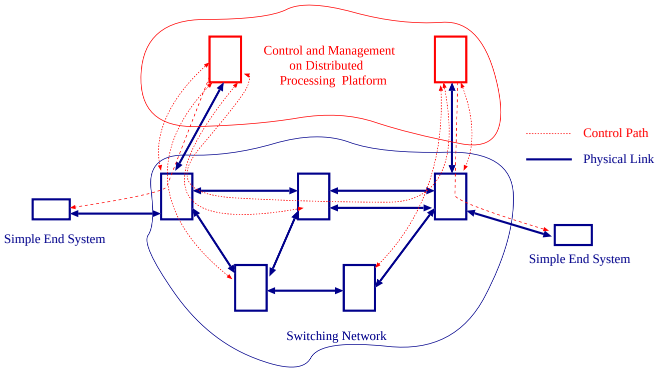
Hard part : Can we make ATM useful?

In Band and Out of Band

- in band : data path
- out of band : control path
- in band control for cells on a particular virtual channel or path.
  - must be processsed quickly, in switches
  - includes RM cells (eg in ABR)
- out of band is everything else
  - signalling (connection control)
  - management, OAM etc.

Devolved Control

Get out of band processing out of switches



Motivation

- flexibility: If you don't know what the applications are, why do you know what the control system should be?
- experimentation: How are you going to find out without experimenting in large networks?
- managing change
- one size does not fit all
- encourage innovation: Open up two markets (switching and control)

Flexibility

- ITU Capability Sets recognise that the signalling system needs to evolve
- ATM Forum PNNI recognises that ITU NNI Signalling isn't appropriate for private networks
- SUN OpeNet: belief that PNNI is perhaps a bit complicated
- Lots of signalling protocols ...

Managing Change

- Evolving signalling protocols mean multiple signalling protocols co-existing on a network
- Switch running multiple versions means available functions limited by last upgrade
- Obsolescence caused by switches not being upgraded
- Will switch manufacturers supply all protocols?

Experimentation

Learn from the Internet

- Routers were originally minicomputers/workstations
- Allowed for experimentation (eg routing protocols)
- As router manufacturers captured functionality, experimentation harder
- But workstations can still be used as routers eg MBONE
- Router manufacturers take on functionality when it matures

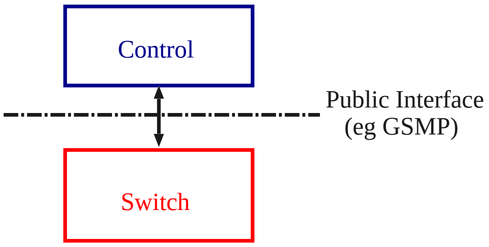
How do you do this in ATM?

One Size Fits All?

- Will set top boxes run Q.2931 over SSCOP?
- Embedded system may want custom control of communication
- Safety critical systems want specialised fail-over
- Would you fly on an airplane relying on a Q.2931 implementation?
- But all will want to use off the shelf switching equipment

Encouraging Innovation

- Separating control from switching encourages new players who can:
  - build hardware
  - build control software
- Switch control protocol must be extensible



- Control may be Q.2931 / UNI 4.0 / PNNI compliant at the same time

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Example: Ipsilon IP

- Simply one example of a control architecture (CA)
- Can view as an embedded system (happens to be IP)
- Clients interact with the CA using IFMP
- Bypassing traditional signalling gains simplicity
- Network gets to optimise use of resources

Some Home Truths

Without flexible, open control ATM is doomed

Rapid response of the IP community to changing applications will be more effective

But

ATM offers a clean separation between control and data paths

- Flexible control does not have to interfere with in band processing, unlike IP
- ATM still best for in-band control

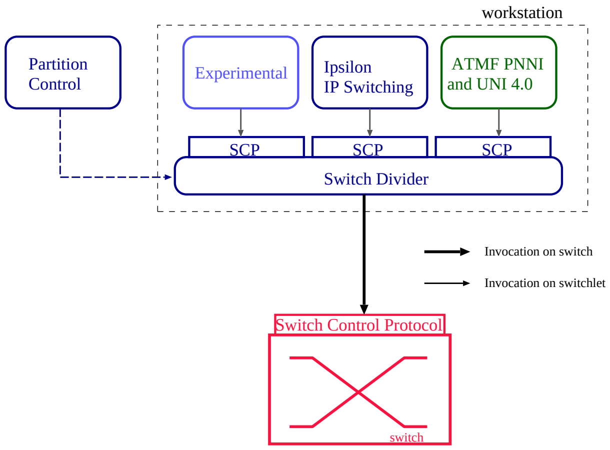
Switchlets

- How do you run multiple control architectures at the same time?
- Need to partition resources of switch
  - buffers
  - link capacity
  - VP/VC address space
- Call these partitions switchlets
- Each may be managed by a different CA
- *Type* of CA is its control policy

Switchlet Implementation

- Assume existence of switch control interface
- First level of control is a divider which enforces the partition of resources
- Divider re-exports the switch control interface to a number of clients
- Clients are also switch controllers and see a subset of the switch resources
- Location of these components is arbitrary

Divider



workstation

Partition Control

Experimental

Ipsilon IP Switching

ATMF PNNI and UNI 4.0

SCP

SCP

SCP

Switch Divider

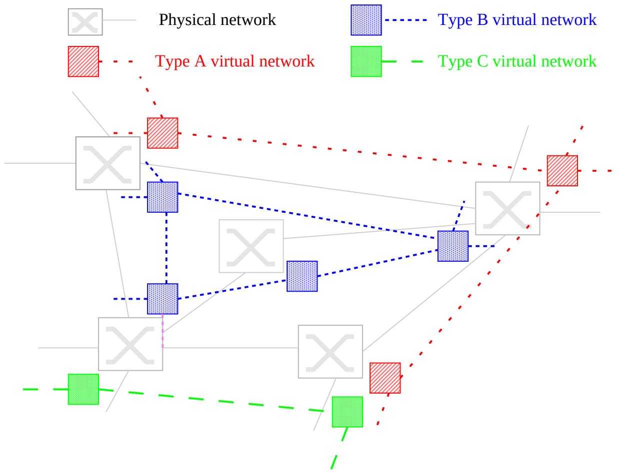
Invocation on switch

Invocation on switchlet

Switch Control Protocol

switch

Switchlet Based Virtual Networks



Creating Switchlet Based Networks

- Need a bootstrap CA (eg: Ipsilon IP)
- Need a network builder : creates switchlets and connects them together
- Network builder must negotiate with dividers to get resources

Using Dynamic Virtual Networks

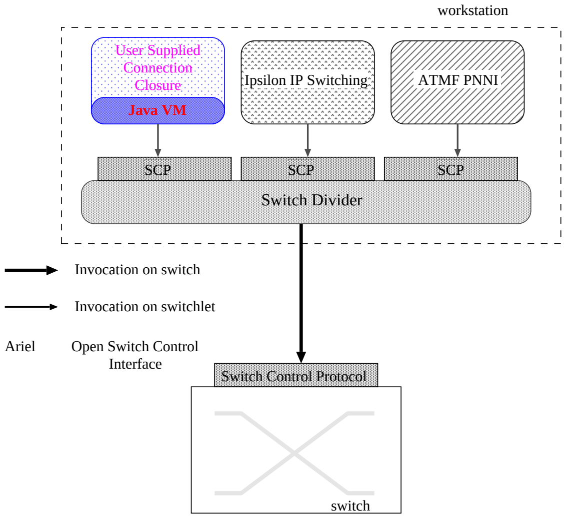
- Can create virtual networks with well defined CAs
- Can create virtual networks with "user" defined CAs
    - specific to a particular service
- Service Specific Control Architectures

1. keep the control system to minimum
2. take advantage of application knowledge

Programming the Network

- Allow the user to supply the CA at runtime
- Like active networks applied to the control plane
- Security issues, but confined to the virtual network
- Applications: Mobility, network resource management

Programming the Network



Networks On Demand

- Dial me up an IP network from `uk.xyz.com` to `usa.xyz.com` from 09:15 to 20:00 with QoS = controlled load
- Requires policy decisions about who can create / manage NoD
- Requires scheduling to allocate link capacities
- CAs still do fast time-scale scheduling of their resources
- Run experimental and production networks on same switches

A Temporary Migration Path?

- Tempting to argue that NoD is only a temporary strategy
- Functionality invented in experimental CAs *may* be adopted by standard CAs
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