Accountability in Hosted Virtual Networks

Eric Keller, Ruby B. Lee, Jennifer Rexford

Princeton University

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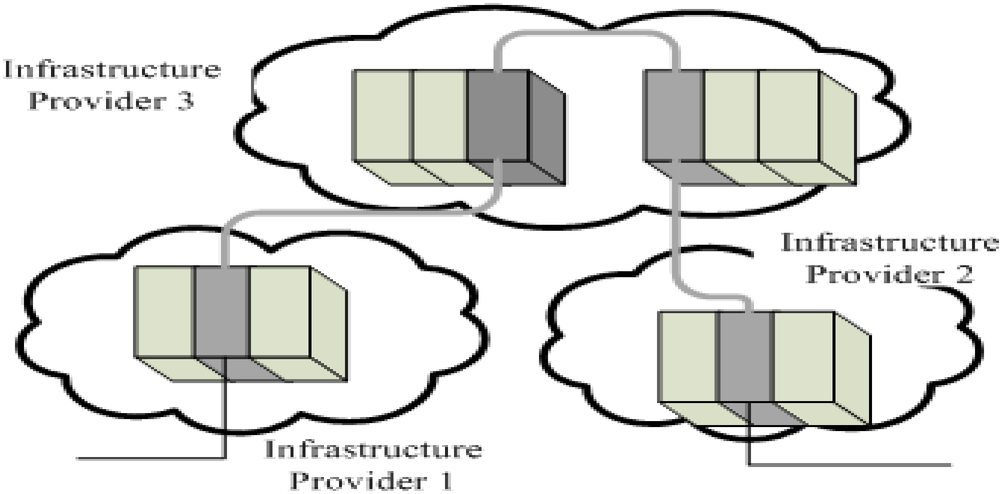
Motivation

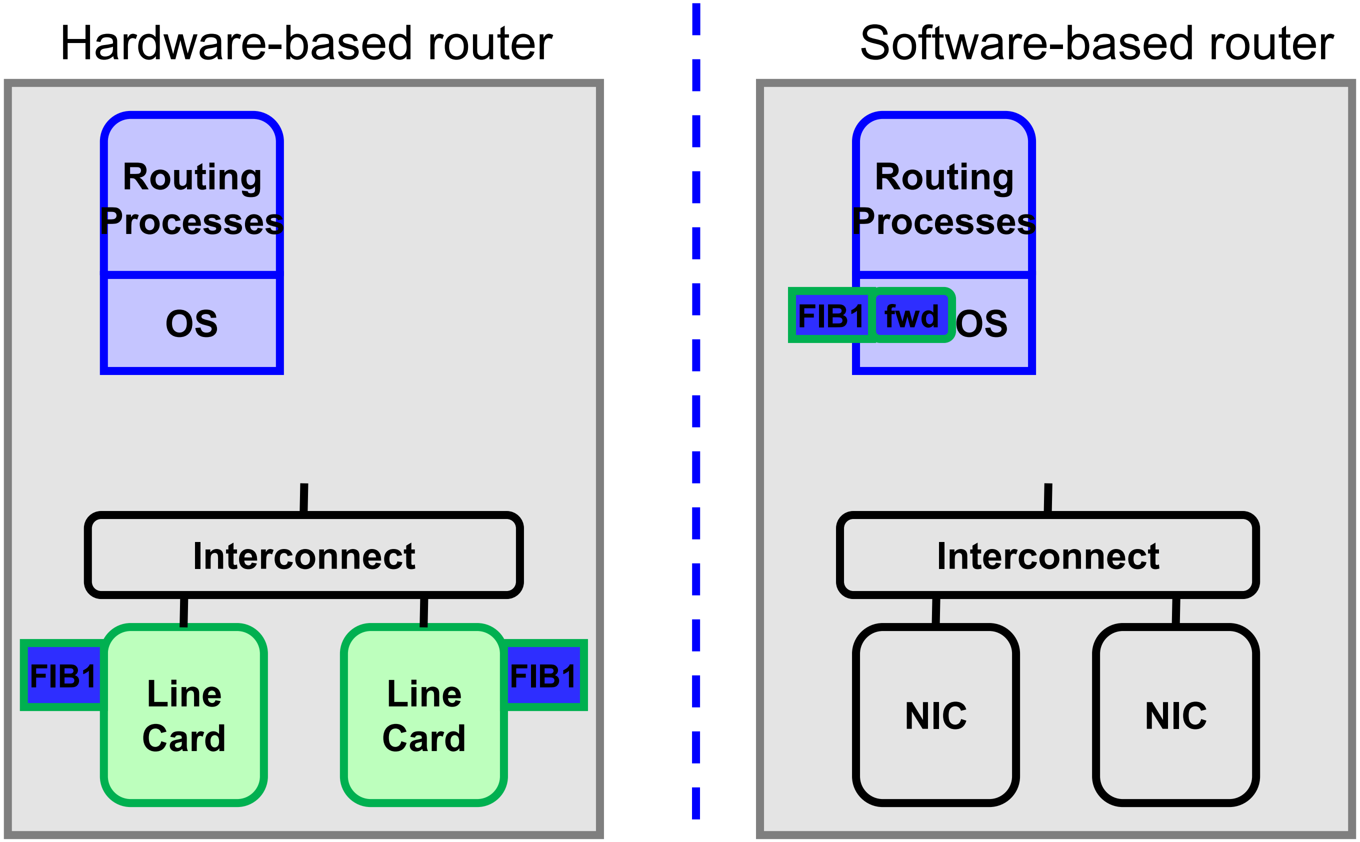
- Trend towards hosted virtualized infrastructures
  - Enables companies to easily deploy new services
  - e.g., Amazon EC2
- Hosted virtual networks
  - ***Infrastructure provider***: owns/maintains routers
  - ***Service provider***: leases slices of routers



Understanding Security Threats

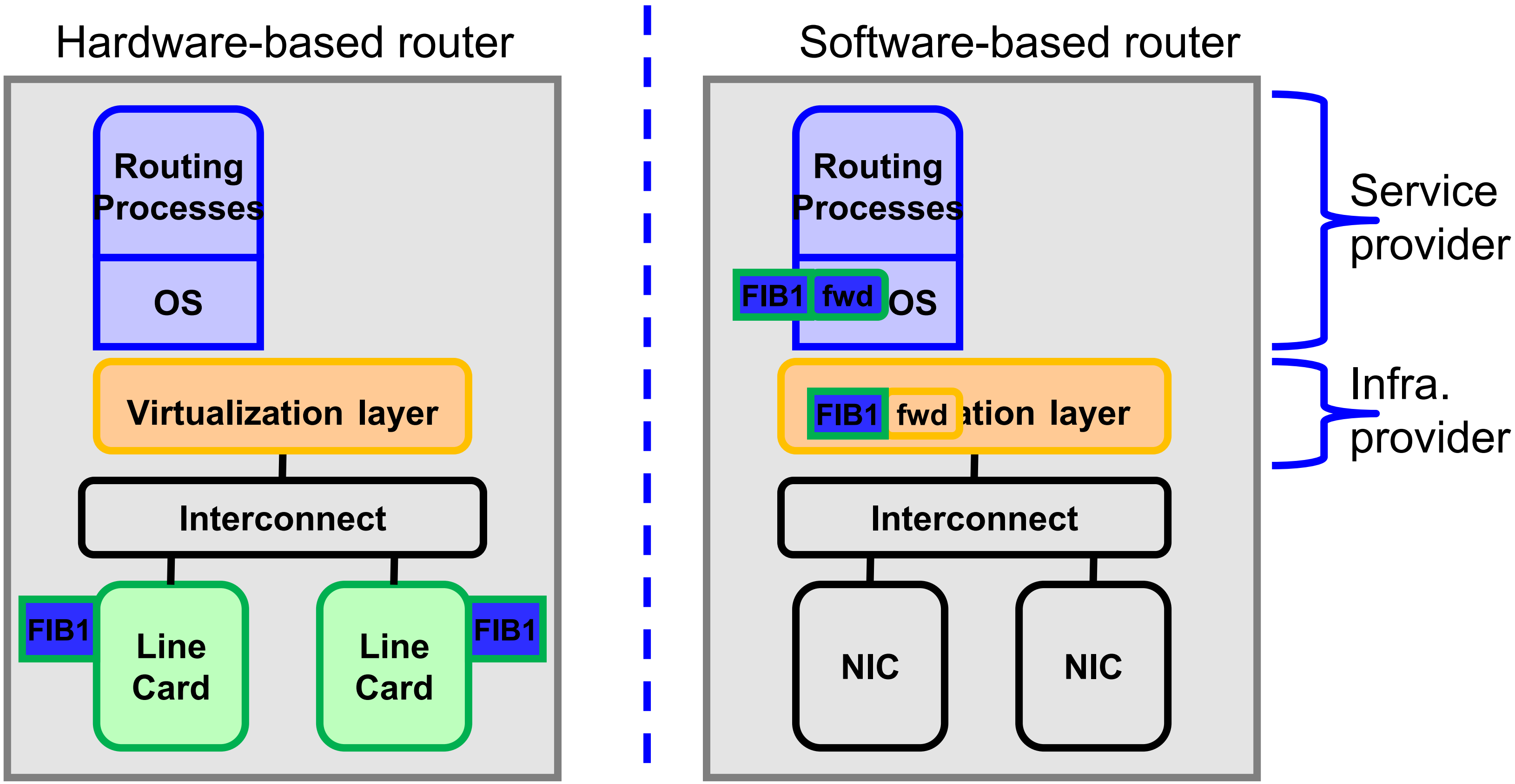
- Service Provider wants
  - Control software running exactly as written
  - Data plane forwarding/filtering as instructed
  - Data plane performing with QoS promised
  - Confidentiality/Integrity of data
  - Availability
- Infrastructure Provider
  - Doesn’t want to be unjustly blamed
- Next: How are these possibly compromised

Old model: Owning the router



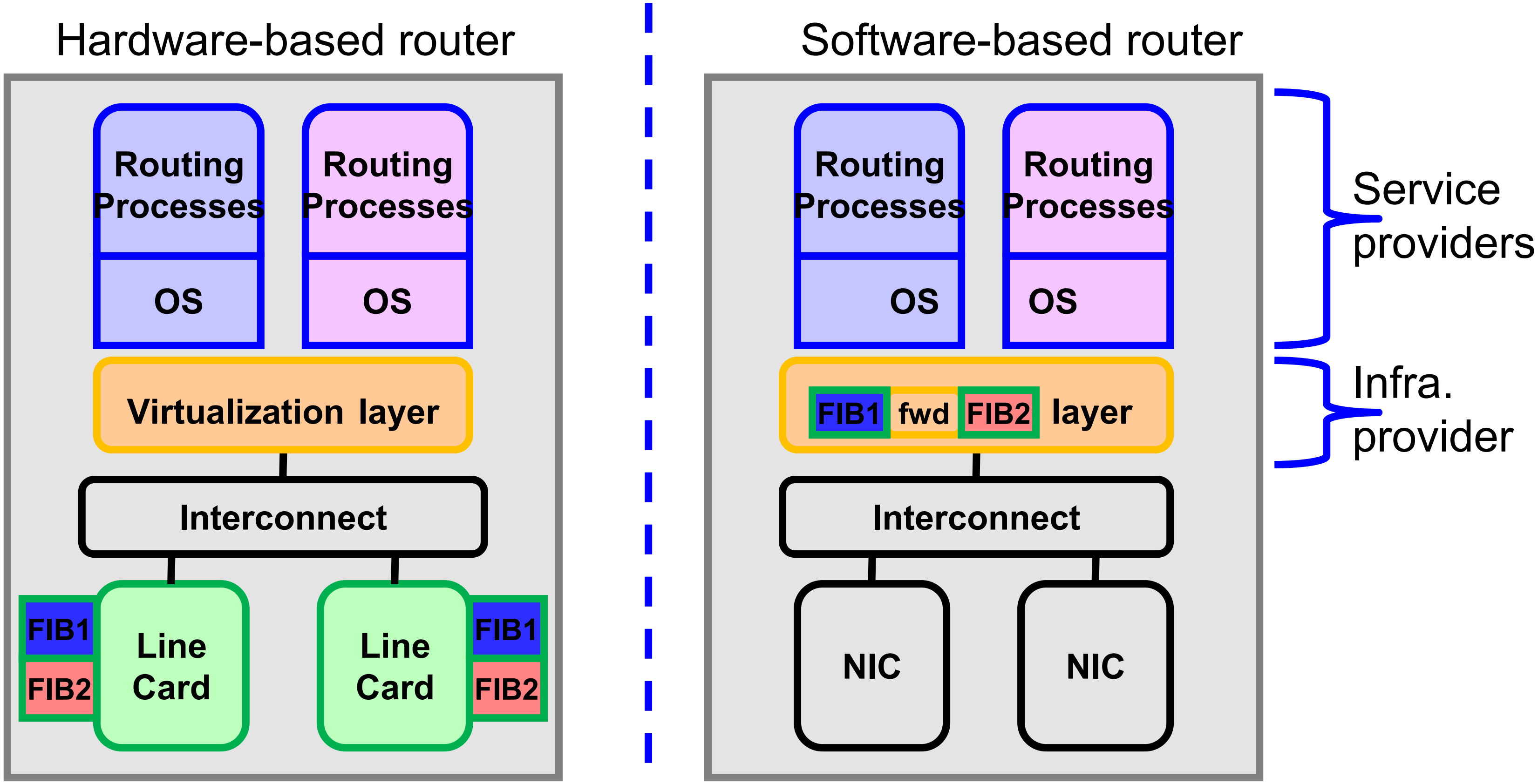
- Entire platform is trusted

New model: Hosted (threat 1)



- Infra. Provider can tamper with control software,
  - data plane configuration (HW router),
  - data plane implementation (SW router)

New model: Shared (threat 2)



- Pink service provider can attack virtualization layer
    - Possible competitor of Blue service provider

Accountability

- Security threats lead to the need for accountability
- Accountable: Subject to the obligation to report, explain, or justify something; responsible; answerable *[Random House]*
- In hosted virtual infrastructure…
  - promised in the Service Level Agreement (SLA)

Outline of Approaches

- Detect
  - Network Measurement
- Prevent
  - Advances in Processor Architecture
- For each
  - Present solution possible today
  - Propose extension

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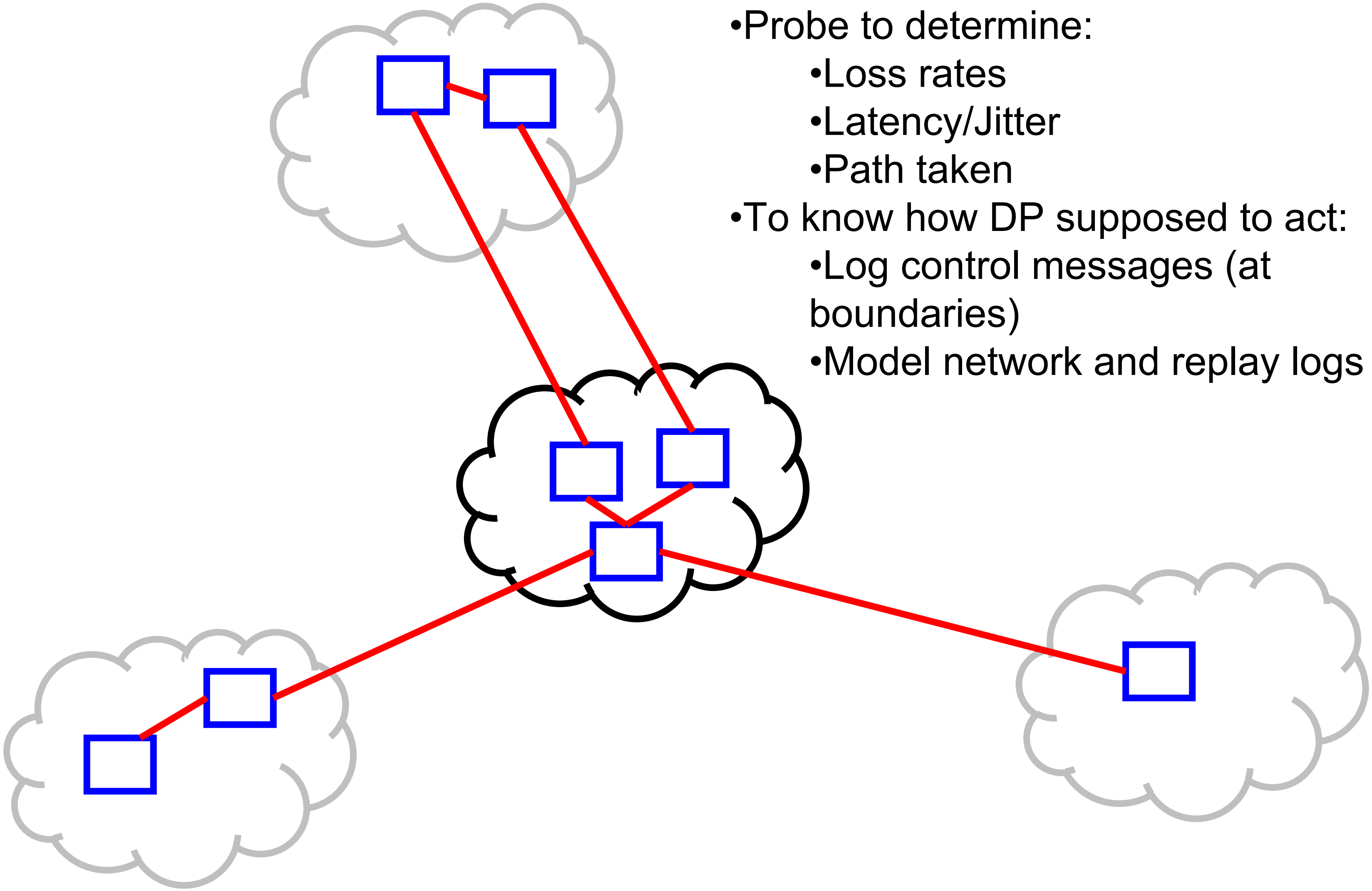
Monitoring SLA compliance



- Probe to determine:
  - Loss rates
  - Latency/Jitter
  - Path taken
- To know how DP supposed to act:
  - Log control messages (at boundaries)
  - Model network and replay logs

Extending the Interface Card

- Treat interface card as trusted (trusting vendor)
- Enables performing measurement at each router
  - Reduces computation overhead
  - Improves accuracy
  - Improves amount of detail
- Enables independent verification

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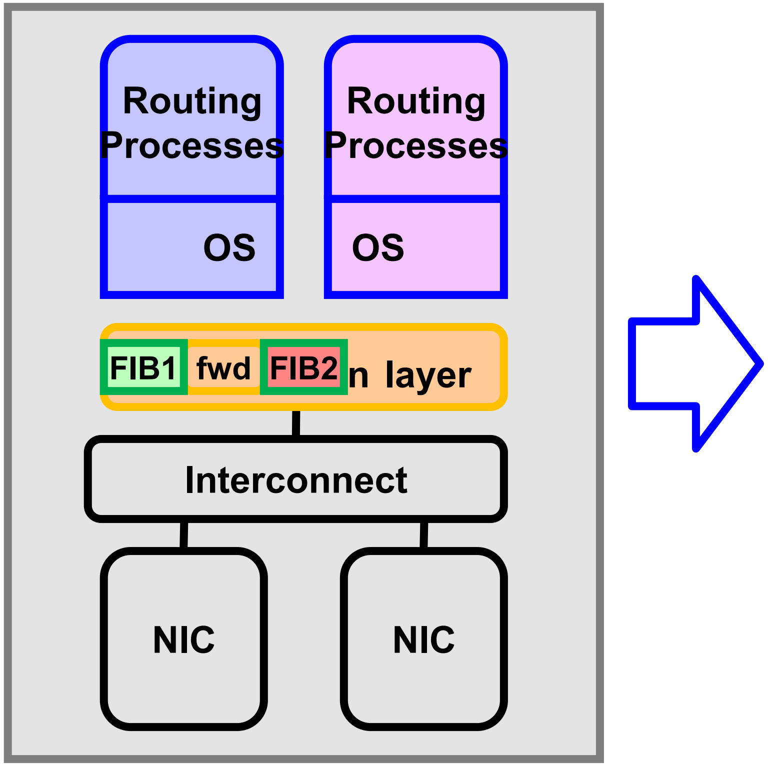
Trusted Platform Module

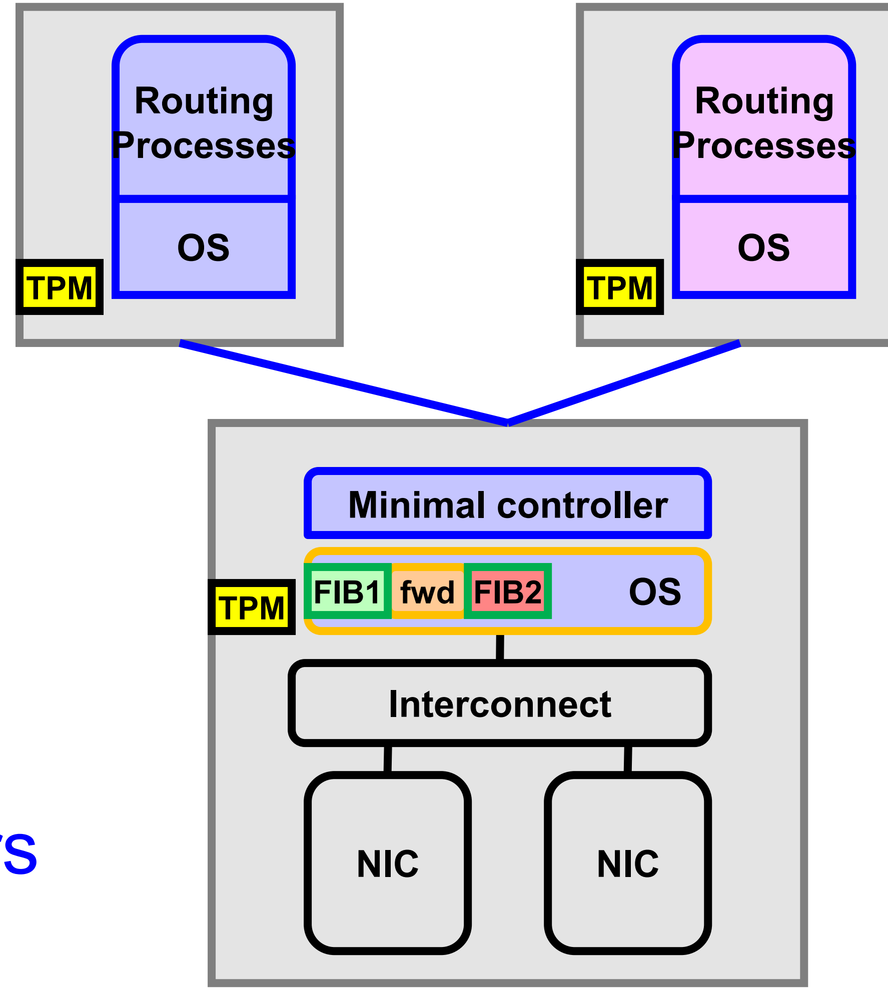
- Recall what service provider wants
  - Control software running unmodified
  - Data plane acting as instructed
  - Data plane performing with correct QoS
  - Confidentiality/Integrity of data
- TPM: Chip on motherboard (on chip in future)
  - Encrypting storage
  - Attesting to integrity of system

TPM Limitations

- Does not protect against dynamic attacks
  - Can't ensure software running unmodified
- Relies on chain of trust
  - Virtual machine verified by virtualization layer
- Implications
  - Can't know if control processes started correctly and haven't been modified
  - Can't know if data plane acting as instructed with QoS (SW - Data plane is in virtualization layer) (HW – Configuration goes through virtualization layer)
  - Confidentiality of data not addressed

TPM needs physical separation





3rd Party Data Plane

- Separate route processors
  (Logical routers)
- Remote control plane
  (4D, Ethane)

Security Enhanced Processor

- TPM relies on physical separation
- Instead – extend processor architecture
  - Confidentiality/integrity of data and software
  - Encryption/decryption to/from memory
  - Examples: SP[ISCA05], AEGIS[MICRO03], XOM[ASPLOS00]
  - Minimal extra circuitry
- None designed for hosted/shared environment
- None made good business case
  - So no (very limited) success
  - Market size of hosted virtualized infrastructures provides the incentive

Protecting Software and Data

- Vendor installs private device key
  - Write only
- Service provider installs a secret key
  - Encrypted with device's public key
  - Sent to infrastructure provider to install
  - Write only
- Service provider encrypts/hashes memory
  - With secret key
- Memory hashed and/or encrypted in main memory
  - Decrypted/verified when cache line pulled in
  - Encrypted/hashed when evicted

What's the right approach?

	Measure	+NIC	TPM	vm-SP
Trust	Other infrastructure providers	Vendor	Vendor	Vendor
Run-time complexity	High	Medium	Low	Low
Confidentiality	No	No	Yes	Yes
Main downside	Accuracy vs computation / storage tradeoff	Need to extend interface card	Requires physical separation	Need general purpose processor extension

- Virtual Mode-SP (extended processor) provides protection desired, minimal complexity, with business incentives to make it reality.

Conclusion

- A step toward realizing hosted virtual networks

- New business model leads to new security issues
  - Platform is hosted and shared
- Can use monitoring to detect violations
- Better to rearchitect routers to prevent violations

- Future work:
  - Virtual Mode-SP for hosted virtualized infrastructures
  - Explore implications of trusting the vendor

Questions