

Sync in an NFV World

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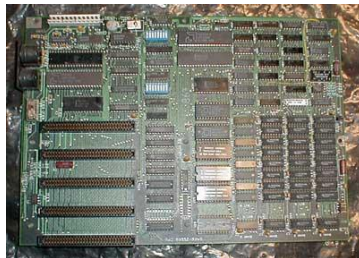
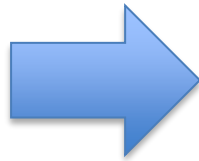
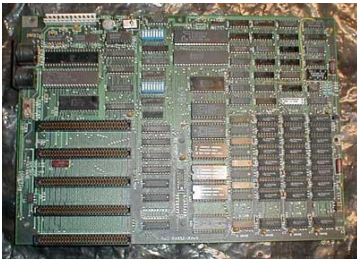


- What are Virtualisation and Network Function Virtualisation?
- Standards for NFV
- Why does NFV affect sync?
- Challenges, Questions, Thoughts
- Summary

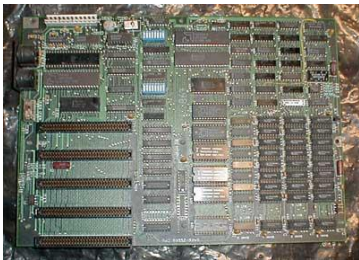
What are Virtualisation and Network Function Virtualisation?

Virtualisation

Doing in software what is traditionally done in hardware by emulating the hardware



```
    'role_id'    => $role_details['id'],  
    'resource_id' => $resource_details['id'],  
    );  
if ( $this->rule_exists( $resource_details['id'], $role_details['id'] ) ) {  
    if ( $access == false ) {  
        // Remove the rule as there is currently no need for it  
        $details['access'] = ! $access;  
        $this->_sql->delete( 'acl_rules', $details );  
    } else {  
        // Update the rule with the new access value  
        $this->_sql->update( 'acl_rules', array( 'access' => $access ) );  
    }  
    foreach( $this->rules as $key => $rule ) {  
        if ( $details['role_id'] == $rule['role_id'] && $details['resource_id'] == $rule['resource_id'] ) {  
            if ( $access == false ) {  
                unset( $this->rules[ $key ] );  
            } else {  
                $this->rules[ $key ]['access'] = $access;  
            }  
        }  
    }  
}
```



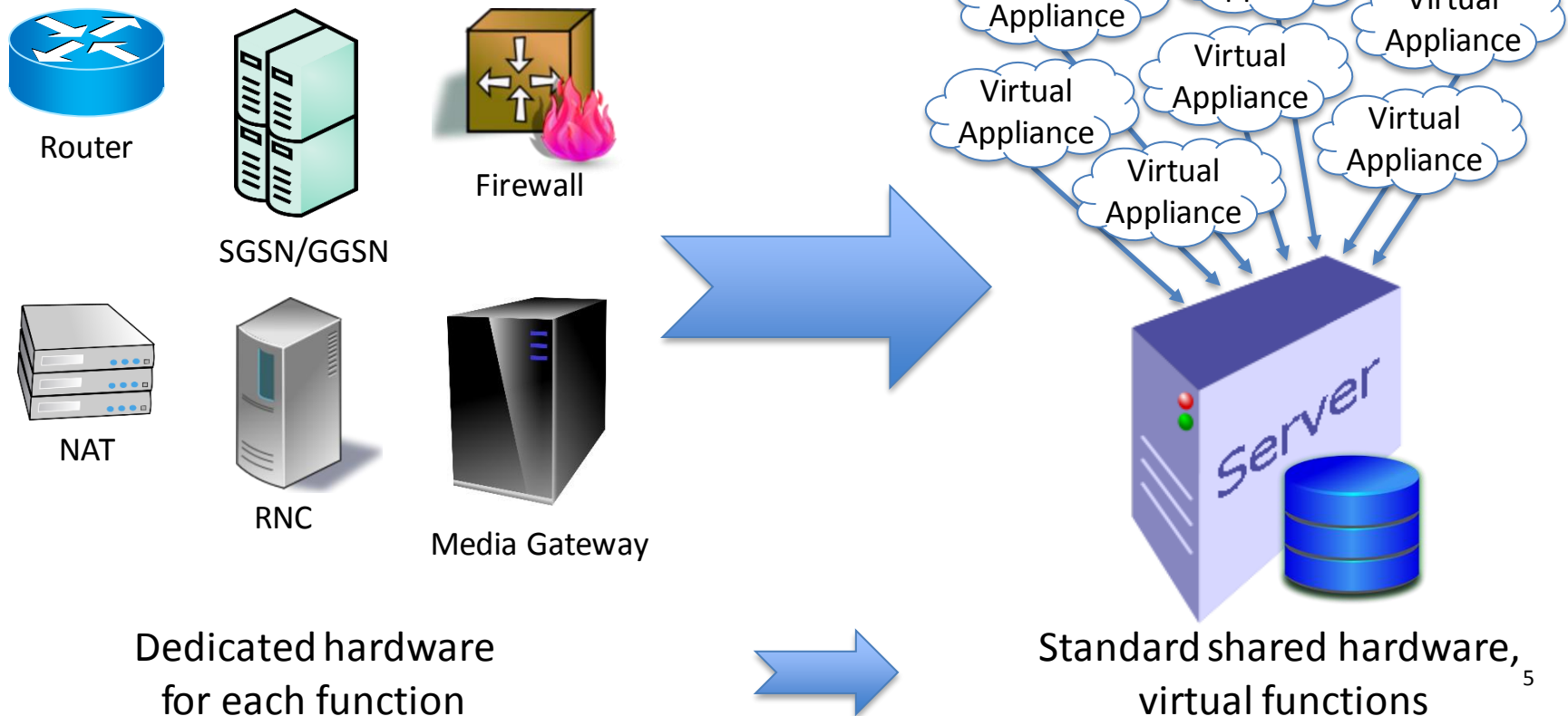
We replace this



With this

What is NFV?

- Network Functions Virtualization
 - The replacement of dedicated network elements with software implementations running on standard servers



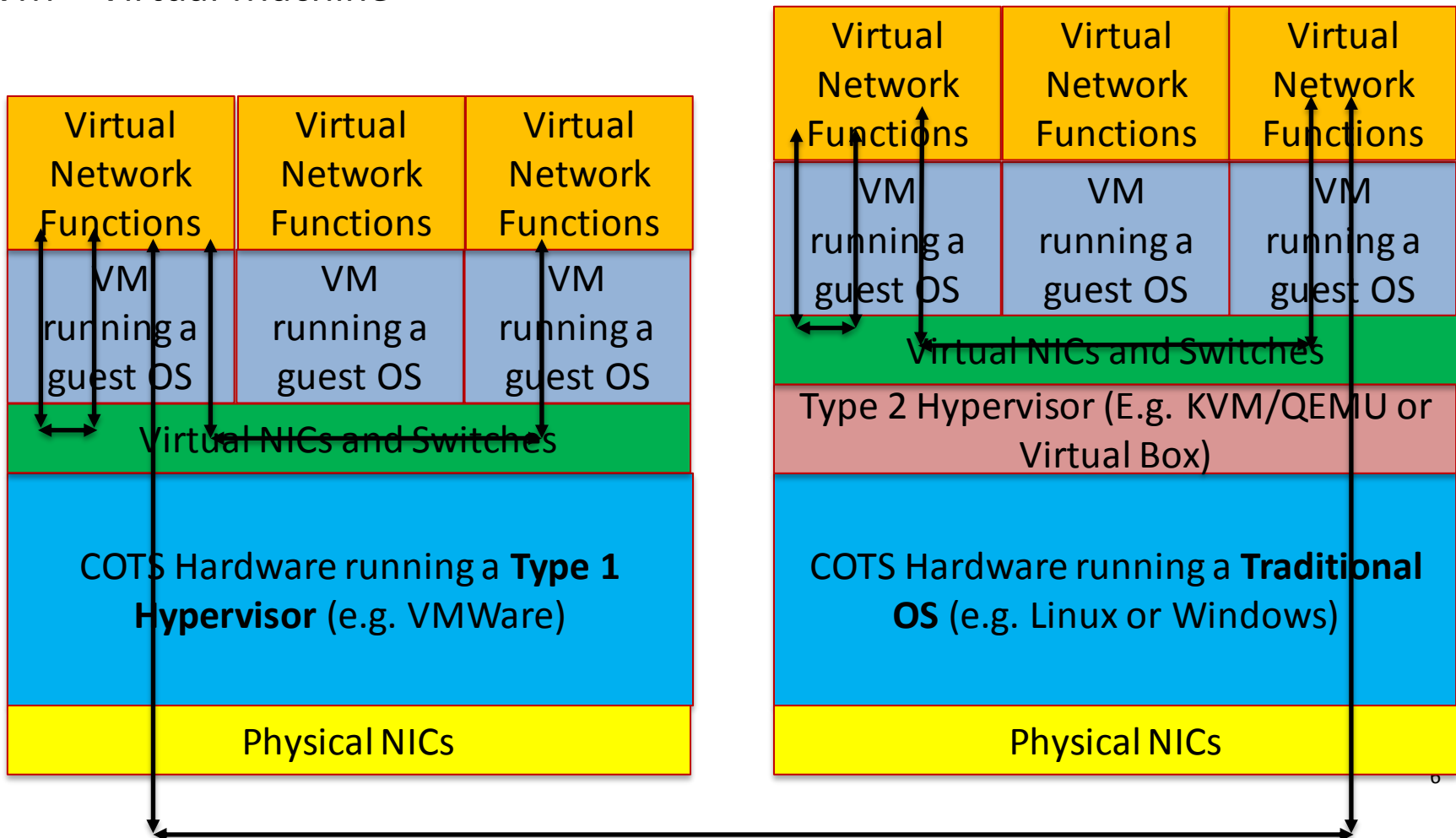
Virtualisation Layers

COTS = Commercial Off the Shelf System

OS = Operating System

NIC = Network Interface Card

VM = Virtual Machine



Why adopt NFV?



+



Massively Increased Flexibility
Greatly Increased Speed of Deployment
and Reconfiguration

Standards

ETSI NFV Reference Architecture

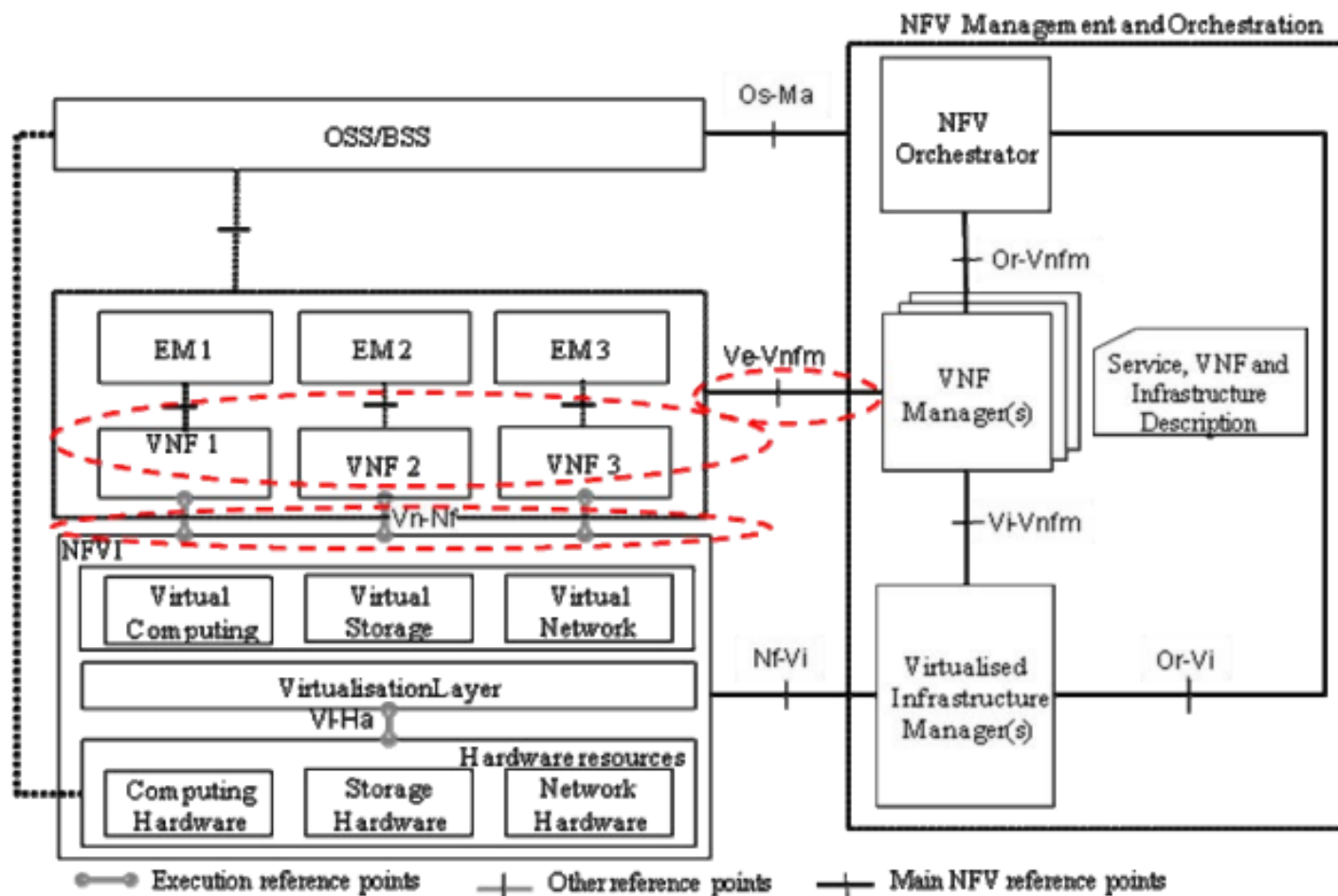


Figure 1: NFV Software Architecture Scope within the NFV Reference Architecture Framework

Standards for NFV Sync



- ETSI have finalized several Standards, Recommendations and Use Cases for NFV.
 - <http://www.etsi.org/technologies-clusters/technologies/nfv>
- Virtualization Requirements document, Section 5.8:
 - http://www.etsi.org/deliver/etsi_gs/NFV/001_099/004/01.01.01_60/gs_NFV004v010101p.pdf
 - Service Assurance suggests the use of IEEE 1588 timestamps
 - Implemented on the NIC to establish a common time base for physical layer and upper layer processes
 - Timestamps to be used as precise time labels for all event processes

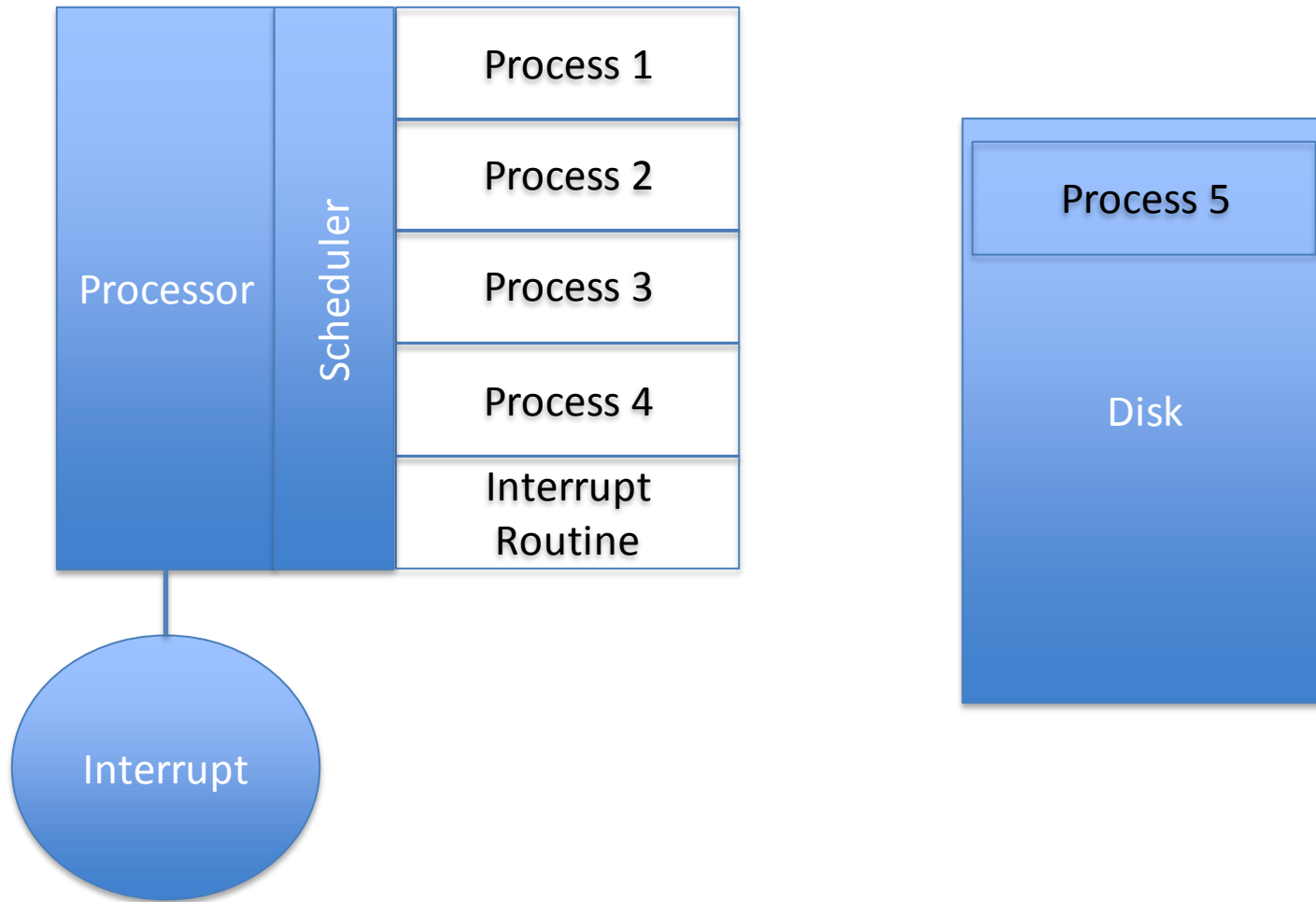
Why does it affect Sync?

Why Does it affect Sync?



- 1) Accurate Sync needs deterministic elements and quality components
- 2) Software is both slower and less deterministic than hardware
- 3) The underlying processor hardware is usually clocked by a relatively low quality oscillator

What Makes Software Less Deterministic?



The processor is usually shared between multiple processes.
The number of active processes typically varies dynamically.
Processes can be swapped out to disk to make space – this takes time.
Interrupts can happen at any time – disrupting the flow of operations

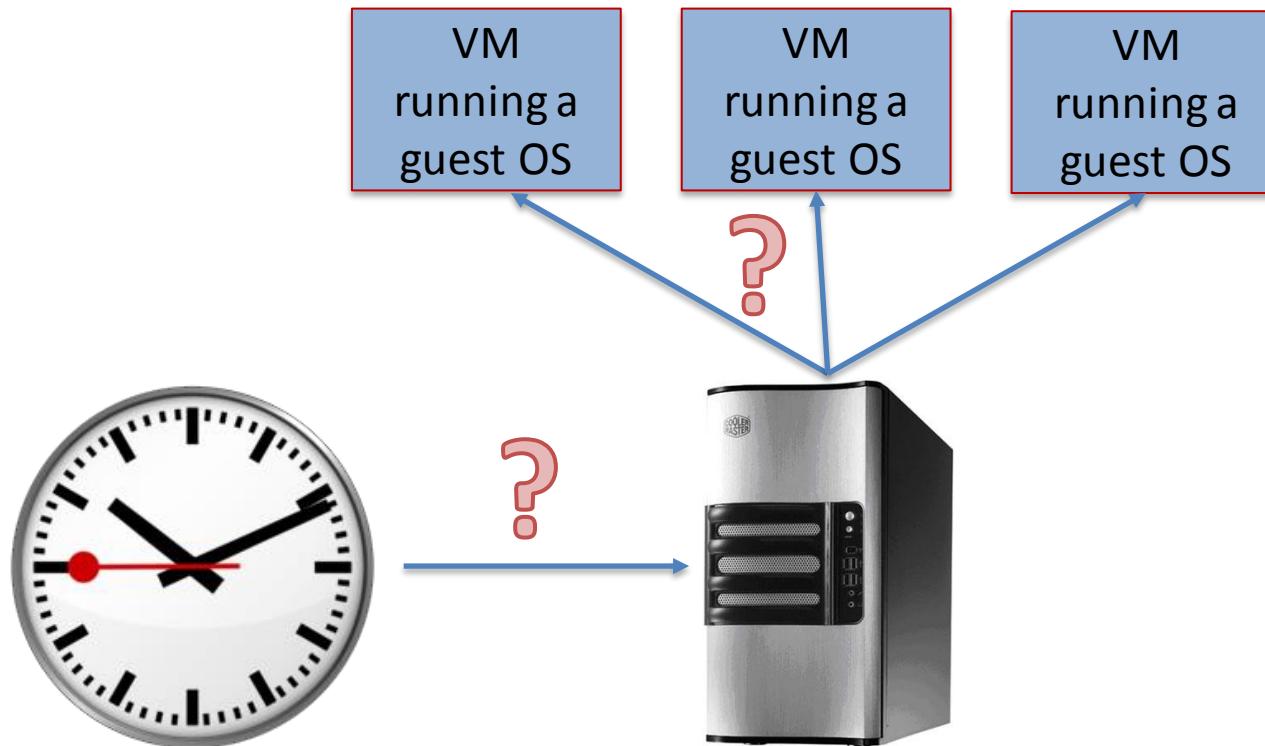
What Else Makes Software Less Deterministic?



- 1) Memory access times vary depending on type
cache, static, dynamic, virtual, etc.
- 2) Modern processor techniques make predictability difficult.
Predicting exactly how long a sequence of instructions will take is very difficult
- 3) Multi-threading and different numbers of processor cores.
- 4) Processors execute at different speeds at different times
A given piece of software will run at a different rate on different machines.
- 5) Software is written in high level languages which are then compiled
Each time the code is changed, the sequence and therefore the timing changes.

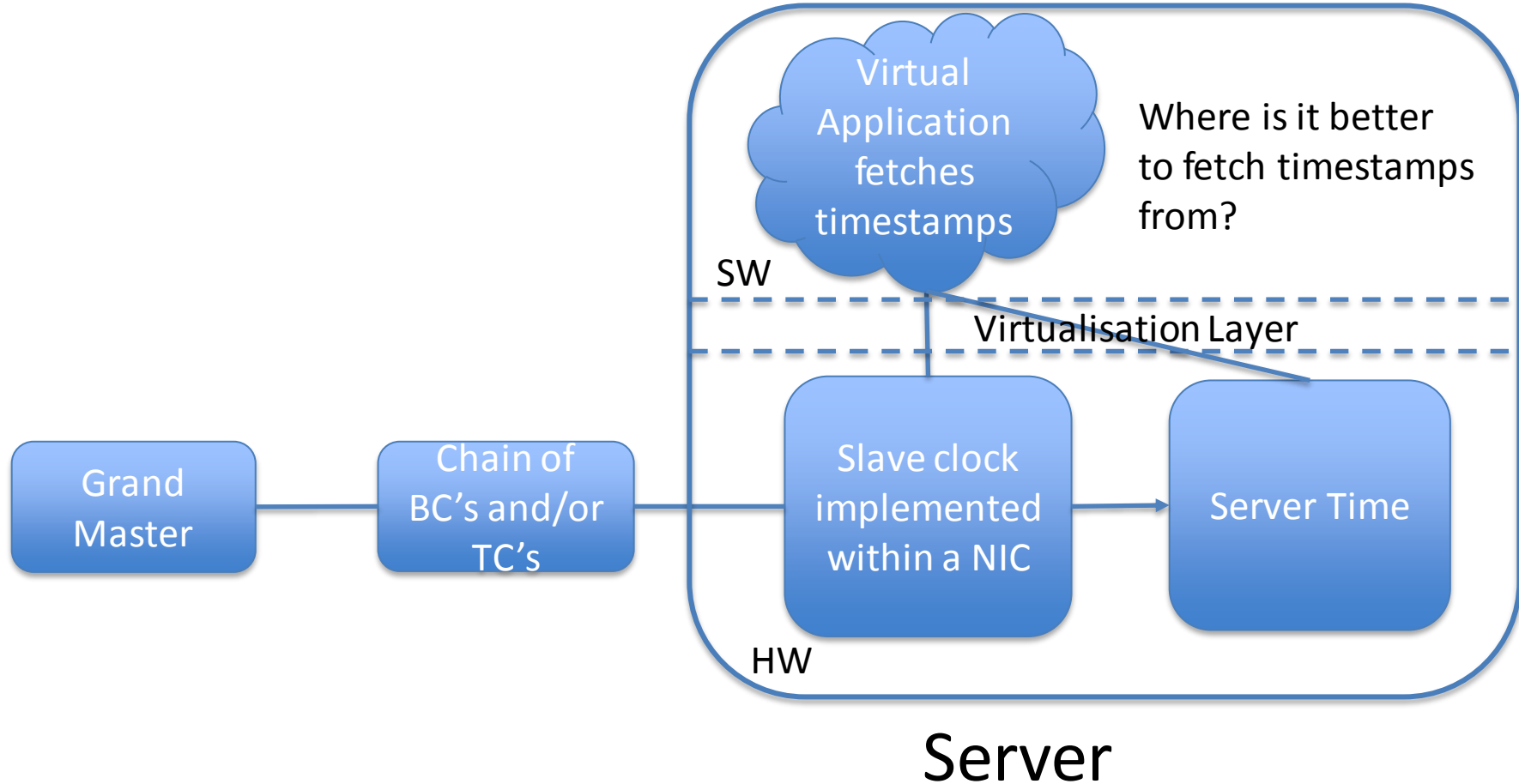
Challenges, Questions and Thoughts for NFV Sync

How Do We Get Accurate Time Into a VM?



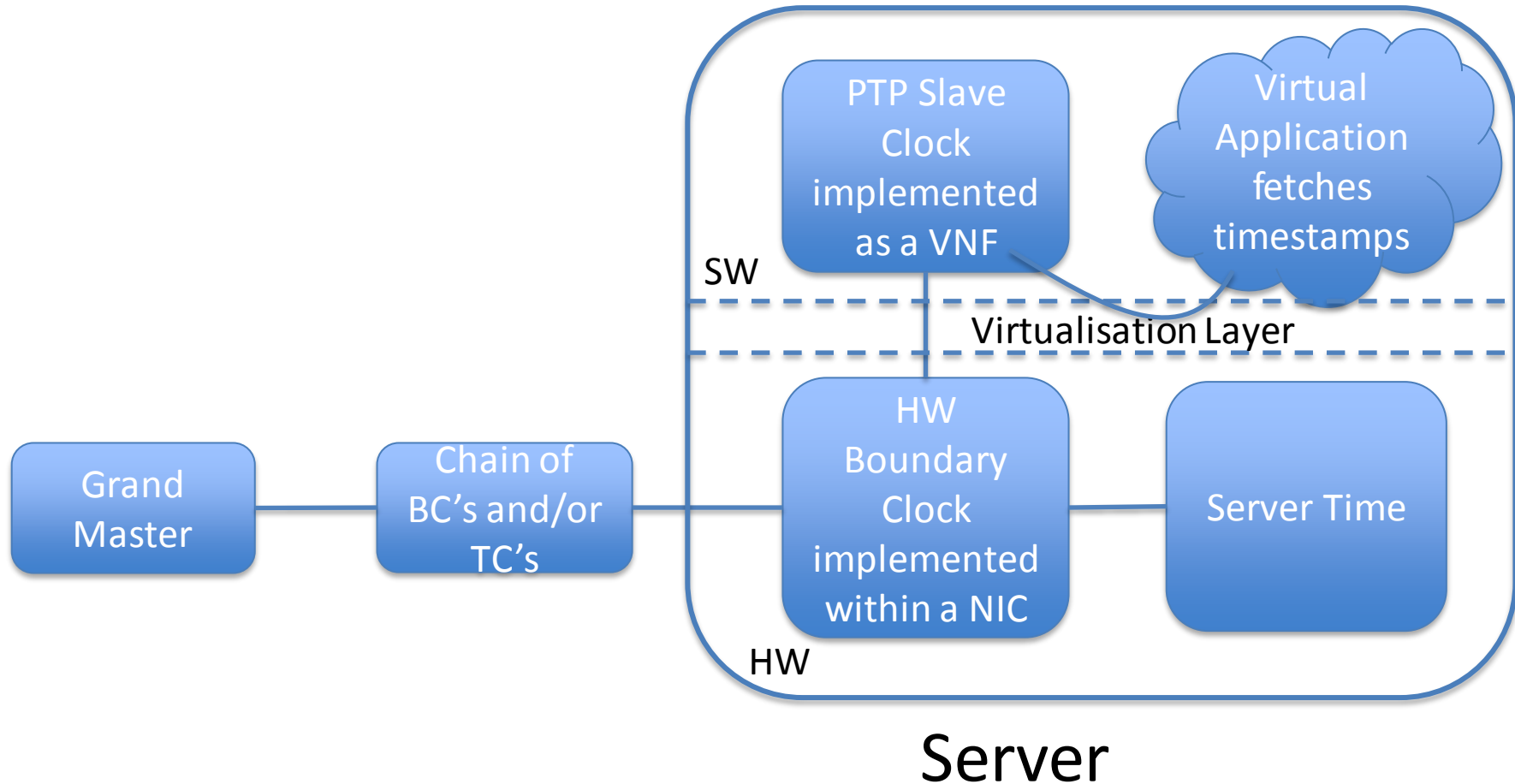
- A sync chain requires dedicated hardware
- Virtualising it will not be good enough for most real world applications
- A boundary clock is a hardware function – making use of oscillators, PLL's etc.
- As soon as we cross into the software domain, things become less predictable.

A Possible PTP Sync Chain



Here we have a HW sync chain – the virtual function fetches timestamps from the external hardware.

A Possible Hybrid PTP Sync Chain



Here we still have a HW sync chain – but we have a PTP slave clock implemented as a Virtual Network Function from which the virtual function fetches timestamps as required.

Measurement is the Key

- 1) Measurement – for SW clock to lock to HW clock
 - 2) Measurement – to check it's still locked
- To specify the system accuracy we have to measure it.
 - The accuracy of the system is only as good as the accuracy of the measurement.
 - The measurement must be traceable to an **accurate and reliable** external reference.



The Measurement Problem

- Determination of event detection and timestamping accuracy within a VM
- Delay characterisation and compensation within a VM
- How do we measure the accuracy of a (software) timing system inside a virtual machine?
- How do we probe such a system?
- How do we avoid using the system to measure itself?

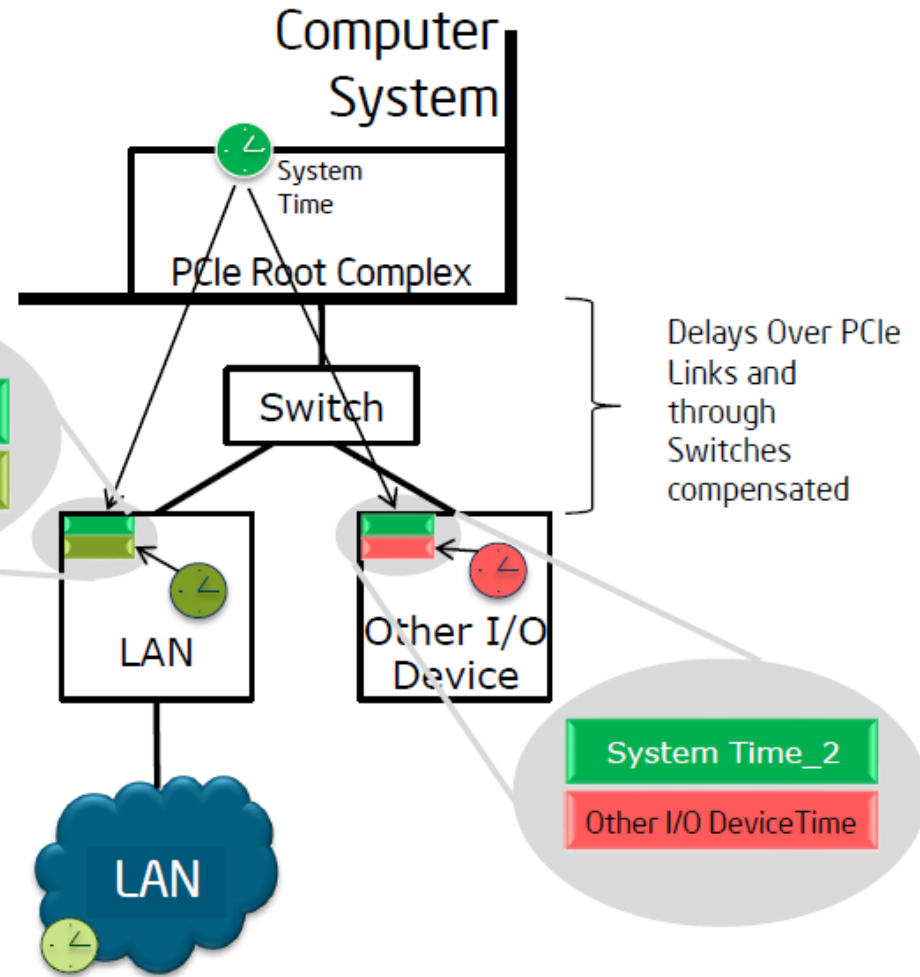
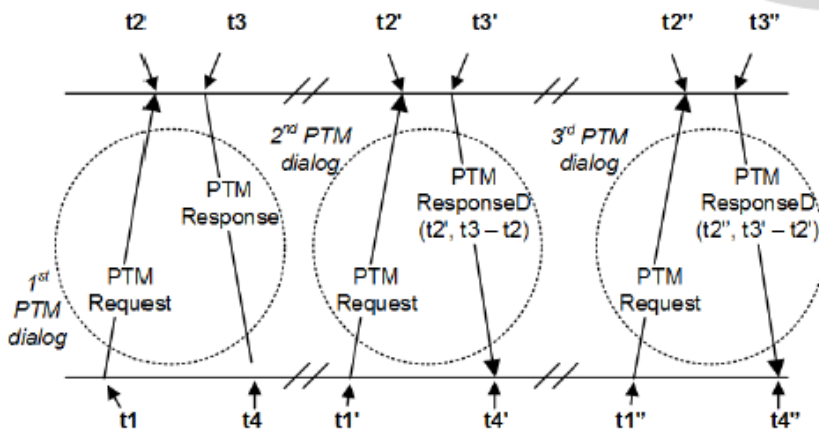
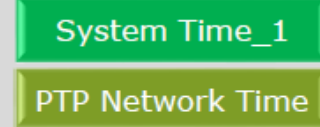
Measuring PTP vs. System Time using PCIe PTM

(Precision Time Measurement)

Scenario:

1. Device Driver Triggers Cross-Timestamp
2. Device initiates *PTM Request* TLP to Root Complex
3. System Time is Returned (delays are compensated)
4. (PTM Time, PTP Time) returned to Device Driver
5. Software "disciplines" two variables per clock: m and b

Cross Timestamps,
Captured Simultaneously



In-System Cross Timestamps → Time Translation Coefficients

Some Big Questions – Research Needed



How accurate might we be able to make a software PTP implementation?

How accurately might we be able to transfer and maintain time within a VM with or without specialised hardware?

How can we solve the measurement problems?

Summary

- NFV is coming, like it or not
 - Most major operators are considering it, if not actively planning for it
 - Probably the biggest shake-up of telecoms networks since voice-data convergence 10 years ago
- Sync will be affected
 - NFV doesn't remove the need for sync, sync methods need to evolve
 - New models of operation will be established
 - New opportunities will be created
 - **Measurement** is the main challenge but we are moving forward
 - Techniques to lock SW to HW in commercial phase
- There is much work to do before software can replace hardware in time critical applications (*if ever*)
- **Are we looking at a new generation of hardware or architecture?**

Wednesday Night Magic



Live at the Gala Dinner – don't miss it!