Designing a Secure Cloud

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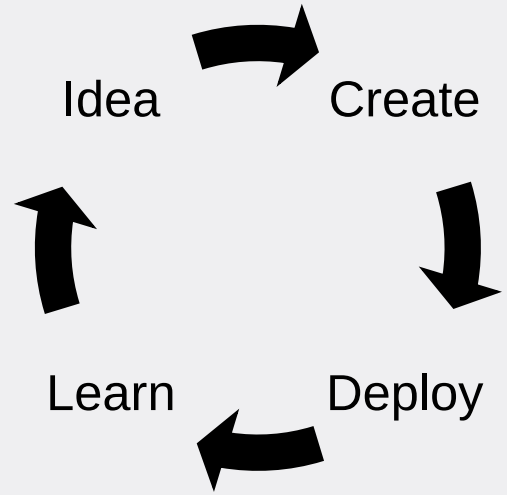
Hybrid Cloud Infrastructure
IBM Research

Paul G Crumley pgc@us.ibm.com
Robert Senger rmsenger@us.ibm.com
Seetharami “Seelam” sseelam@us.ibm.com
Ming-Hung Chen minghungchen@ibm.com
Jaime H Moreno jhmoreno@us.ibm.com

Cloud Data Centers are evolving quickly, fueled by business needs

Cloud infrastructure and processes can increase business velocity



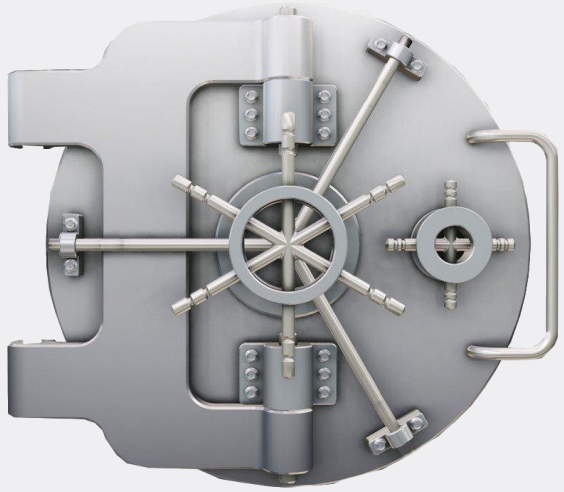
Infrastructure is consumed using **APIs** to integrate with DevOps and to enable automation

When there are few constraints, **ideas can evolve quickly**

- Many ideas do not survive to experience “enterprise” issues

Requirements I hear from enterprise clients for cloud infrastructure

Enterprises desire the benefits of cloud
but have demanding requirements



Security: Integrity, Isolation, Business Continuity

Compliance: Validation, Immutable Logs, Reporting

Risk / Cost: Reducing risk can be more significant than financial cost

Examples of enterprise requirements conflicting with legacy designs in cloud

Firmware is used to implement critical aspects of security and data functions

- Where does this firmware come from? Who validates it?
- Blindly installing new FW / SW can get one fired ☹

Proliferation of interfaces for (remote) control

- Many ad-hoc & legacy solutions. **Far too much "magic"**
- Clients must be isolated from the configuration and management functions

Mechanisms to debug and validate systems in situ

- Signal injection of test data and errors is done to validate error detection and correction
- These allow any memory, register, or signal to be interrogated

Some devices **claim** isolation

- Our tests have penetrated some of the security barriers
- We need provably correct devices and secure interface protocols

Two Challenges

How do enterprise clients **trust** cloud infrastructure?

- They must be able to examine the hardware, firmware, and software
- Must know the configuration of resources being used
- Mechanisms enforce configurations and capture data for verification

How to **securely** provide **flexibility and efficiency**?

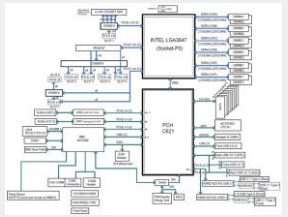
- Traditional techniques often bring problems
- No “Magic Permitted”
- Tension between security and programmatic configurability

What work needs to be done now to meet these challenges?

- Are there designs and interfaces which should be deprecated now to prepare?

A Current Research Project: Isolation & Trust using DC-SCM & OpenBMC

Problem: How do clients trust the infrastructure?



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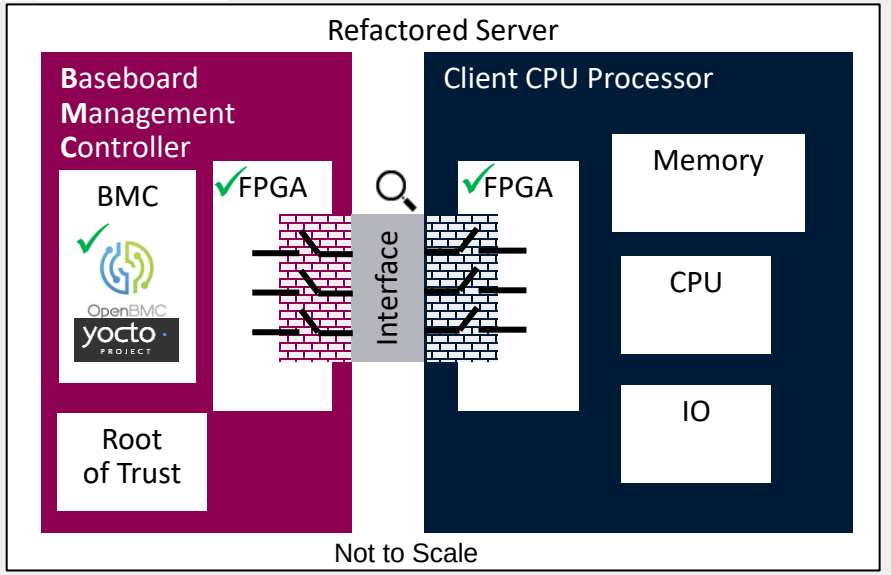


DC-SCM: (Data Center – Secure Control Module)

- Separate management and client boards with defined interface
- Any interactions across boundary are observed and logged
- Clients have hardware isolation from administrators
- Administrators have hardware isolation from clients
- Client board can be stateless to eliminate temporal attack "surfaces"

OpenBMC: (Baseboard Management Controller)

- Community provides an open implementation of the management code running in the BMC board
- Clients can inspect code and map source code to signatures
- Clients can verify ✓ the signature of code which impacts resources a client is using
- Unneeded BMC code can be removed to reduce attack surfaces and bugs
- Specialized BMC and CPU code can be loaded, when needed, for debug / validation purposes

Relative Scale

*Supermicro X11SPA T Block Diagram

Some Longer-Term Research Work: Secure Resource Composability

Secure composability is already a capability in enterprise systems

- The are “partitioned”, not “shared”

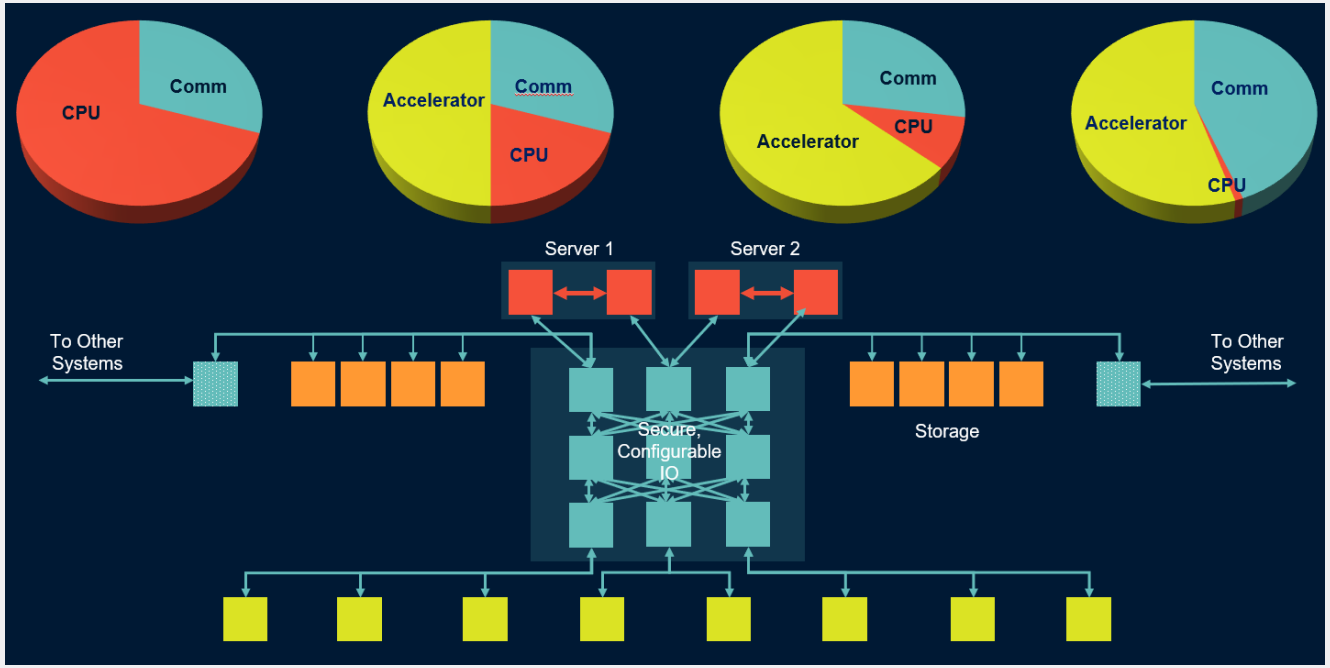
Secure Composability allows resources to be tailored to workload

- Used to provide security, performance, and legacy support

Working with technology communities to develop the base technologies

- Open Compute Project
- CXL / PCI-SIG / Open Fabrics

Our research team is investigating secure composition capabilities for a broader set of workloads at larger scale



Additional Areas for Exploration

Architecture for secure, multi-tenant cloud

- Current architectures and system components are designed for a different time and place
- How to securely and efficiently map cloud abstractions and processes to infrastructure
- Is sharing over-rated?

Secure mechanisms for telemetry, validation, and debug

- How can infrastructure provide debug/configuration capabilities without compromising security?

Tools & Processes to validate designs and ensure supply chain security

- Design and verification for security requirements from the start
- How do we know the boards and modules precisely match the specifications?

What attack surfaces can we eliminate?

- Don’t spend effort hardening problem spots that can be removed
- Every component must be essential to keep verification cost manageable and reduce risk
- Paul’s personal goal is to remove all persistent firmware storage from infrastructure

Summary

Opportunities to expand cloud adoption by addressing challenges of

- **Security**: Integrity, Isolation, Robustness
- **Efficiency**: Secure and flexible configuration of resources

Next steps: Call to action

- Many other topics to allow us to securely tailor infrastructure for cloud
- What must be done **now** to clear a path to better security in cloud infrastructure
- Help us grow the community with more academic ideas and projects

Thank you for your time and attention

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