Novonanmek

Three-Point Architecture Principle

The Common Architectural Frame for HOPT-AS, HLAS, NRIA and NEIA

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Abstract

The increasing complexity of infrastructure and engineering systems creates a need for standardization. Project-specific approaches repeatedly require fundamental decisions concerning system boundaries, interfaces, classifications, relationships, and permitted configurations. A consistent approach requires a common architectural structure within which these decisions can be defined.

To address this need, Novonanmek Material Sciences developed the **Three-Point Architecture Principle**:

END 1 → INTERMEDIATE → END 2

The principle establishes a common **architectural frame** consisting of two terminal positions and the intermediate structure between them. The frame does not prescribe a particular technology, component, engineering solution, or physical configuration. Rather, it establishes the fundamental structural positions within which an architecture can be defined and standardized.

The Three-Point Architecture Principle was established as the foundation for developing four distinct Novonanmek architectures: **Hub-Only Pipeline Topology Architecture Standard (HOPT-AS), Hydrogen Logistics Architecture Standard (HLAS), Nuclear Repowering Interface Architecture (NRIA), and Nuclear Engineering Interface Architecture (NEIA).**

Each framework populates the common architectural frame with domain-specific elements, classifications, interfaces, relationships, compatibility rules, and compliance requirements. The contents differ according to the technical domain; the underlying frame remains consistent.

The principle therefore represents a deliberate architectural methodology for standardization:

The Principle defines the Frame. The Framework defines what occupies the Frame and how the occupants relate within it.

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1. Why Standardization Matters

Infrastructure is rarely developed in isolation. Individual facilities, technologies, interfaces, transportation systems, energy systems, and industrial assets increasingly form parts of larger and continuously evolving systems.

Yet the fundamental architecture of these systems is often established on a project-by-project basis.

Each project may independently determine:

- what constitutes an architectural element;
- where the system begins and ends;
- where interfaces are located;
- which components may occupy particular positions;
- which combinations are permitted;
- which combinations are prohibited;
- how different elements may interact; and
- how the system may expand or evolve.

When these fundamental decisions are repeatedly recreated, similar technical problems produce different architectural solutions.

The result is architectural fragmentation.

Standardization addresses this problem by moving fundamental architectural decisions from the individual project to a defined framework.

Instead of asking every project to establish its own basic architectural structure, a standard establishes that structure in advance.

Standardization therefore provides:

- **Consistency** — common architectural definitions and boundaries.
- **Repeatability** — recurring architectural problems can be addressed through established structures.
- **Comparability** — different projects can be classified using common architectural criteria.
- **Interoperability** — relationships between architectural elements can be defined consistently.
- **Scalability** — new elements can be incorporated within an established structure.
- **Governance** — architectural conformity can be assessed against defined rules.
- **Technology flexibility** — different technologies can occupy the same architectural position when they satisfy the applicable requirements.

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The objective is not to make every project identical.

Standardization establishes the common architectural structure within which different projects and technologies can be developed.

This distinction is fundamental.

HLAS, for example, explicitly establishes an architecture rather than prescribing the engineering design of individual facilities, pipelines, storage assets, production technologies, or transport modes. It governs the relationships between infrastructure components.

HOPT-AS similarly establishes Architecture Classes, architectural boundaries, and architectural conformity rather than equating standardization with a particular detailed engineering design.

Standardization therefore begins with a more fundamental question:

What common architectural structure should exist before the domain-specific elements and engineering solutions are defined?

For the four Novonanmek architectures addressed in this paper, the answer is the **Three-Point Architecture Principle**.

2. The Three-Point Architecture Principle

The Three-Point Architecture Principle defines the fundamental architectural frame:

END 1 → INTERMEDIATE → END 2

The three points establish three structural positions within the architecture.

End 1: End 1 represents the first defined terminal position of the architecture.

Intermediate: The Intermediate represents the structural space, relationship, or interface architecture between the two terminal positions.

End 2: End 2 represents the second defined terminal position of the architecture.

The important point is that these three positions constitute a **frame**.

They do not, by themselves, prescribe what technology, equipment, infrastructure, or engineering solution must occupy each position.

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The frame establishes **where the architecture is defined**.

The domain-specific framework then establishes **what belongs there**.

Therefore:

The Three-Point Architecture Principle standardizes the frame, not the contents of the frame.

This distinction separates the fundamental architectural principle from the individual standards developed from it.

3. The Architectural Frame

The concept of the frame is central to the Three-Point Architecture Principle.

A frame establishes a stable structural arrangement while allowing its contents to vary.

The same architectural frame can therefore support different domain-specific architectures.

In one application, the three positions may represent physical hubs and a corridor.

In another, they may represent a production source, a logistics corridor, and a terminal aggregation function.

In another, they may represent an existing turbine envelope, an interface architecture, and a nuclear heat-output requirement.

In another, they may represent application demand, energy integration architecture, and reactor capability.

The frame remains:

END 1 → INTERMEDIATE → END 2

while the architectural occupants change.

This is what allows the principle to support standardization without requiring technological uniformity.

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4. The Principle and the Framework

The relationship between the principle and the individual frameworks can therefore be stated clearly.

Three-Point Architecture Principle
Defines:

The Frame

Domain-Specific Architecture

Defines:

The occupants of the Frame

and:

The relationships and rules governing those occupants

This creates two distinct levels of standardization.

Level 1 — Structural Standardization
The Three-Point Architecture Principle establishes the common three-point frame.

Level 2 — Domain Standardization
Each framework defines the classifications, building blocks, interfaces, relationships, compatibility rules, and compliance requirements applicable within that frame.

The distinction is important because the four frameworks are not simply four examples of the same technical architecture.

They are four **different architectures constructed using the same architectural frame**.

5. Development of the Four Architectures

Based on the Three-Point Architecture Principle, Novonanmek developed four domain-specific frameworks.

Architecture	End 1	Intermediate	End 2
HOPT-AS	Hub	Pipeline / Corridor Architecture with Sink & Utilization points	Hub
HLAS	Production Hub	Hydrogen Corridor with Large Uses & Regional hubs	Regional Aggregation Hub / Export Hub

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NRIA	Envelope Family (EF)	Interface Architecture Class / Interface Boundary	Heat Output Class (HOC)
NEIA	Demand Envelope Class (DEC)	Energy Integration Architecture (EIA)	Reactor Capability Class (RCC)

The table demonstrates the central proposition of this paper.

The **frame is common**. The **architecture within the frame is domain-specific**.

6. HOPT-AS and HLAS — The Spatial Frame

In HOPT-AS and HLAS, the Three-Point Architecture Principle is expressed most visibly as a spatial architecture.

The Standardization Corridor work identifies the common three-part structure as:

End 1 → Intermediate Length → End 2

For HOPT-AS, the structure places Hub A at End 1, a pipeline-based storage/utilization corridor within the Intermediate Length, and Hub B at End 2. Standardization Corridor

HLAS applies the same frame through its formal corridor structure. Every Hydrogen Corridor comprises:

- End 1;
- Intermediate Length; and
- End 2.

HLAS then defines what may occupy those positions. End 1 contains exactly one Production Hub. End 2 contains exactly one Regional Aggregation Hub or Export Hub. Intermediate positions may contain specified Architecture Building Blocks.

The important distinction is that **HOPT-AS and HLAS do not standardize the same infrastructure**.

They standardize different architectures **within the same structural frame**.

7. NRIA and NEIA — The Functional Frame

The same principle can be applied when the architecture is not primarily geographical.

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NRIA uses the three-point structure to organize the relationship between an existing turbine condition and a nuclear heat-output requirement.

Its architecture can be represented as:

Envelope Family → Interface Architecture → Heat Output Class

The Interface Architecture and Interface Boundary Points establish the architectural mechanism through which the nuclear and conventional domains are related. NRIA therefore converts what could otherwise be a project-specific integration problem into a classified architectural relationship. IAC-IBP(20261007-045002)

NEIA applies the same structural logic to reactor-to-application integration:

Demand Envelope Class → Energy Integration Architecture → Reactor Capability Class

The framework first classifies application demand and reactor capability independently. Compatibility rules then determine the required Energy Integration Architecture. The deterministic matrix maps DEC and RCC combinations to allowed, prohibited, or conditional integration architectures.

Here again, the frame is preserved while its contents change.

The Three-Point Architecture Principle is therefore **not inherently spatial**.

It is an architectural principle.

8. What Is Actually Being Standardized

The central distinction can now be stated precisely.

The Three-Point Architecture Principle does **not** standardize:

- A particular pipeline;
- A particular hub;
- A particular reactor;
- A particular turbine;
- A particular interface technology;
- Or a particular engineering solution.

It standardizes the **architectural frame in which those elements are defined**.

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The individual framework then standardizes what is placed within that frame.

Accordingly:

The Three-Point Architecture Principle standardizes the structure of the architecture.

And:

The individual framework standardizes the contents, relationships, classifications, and rules within that structure.

This is why different technologies can participate in the same standardized architecture without becoming identical.

9. The Value of the Architectural Frame

A common frame provides a stable reference for future development.

Once the frame exists, additional standardization becomes systematic.

The framework can define:

1. **What may occupy End 1**
2. **What may occupy the Intermediate**
3. **What may occupy End 2**
4. **Which relationships are permitted**
5. **Which relationships are prohibited**
6. **Which relationships are conditional**
7. **Which interfaces are required**
8. **How compatibility is determined**
9. **How changes are evaluated**
10. **How architectural conformity is maintained**

This converts an open-ended engineering problem into a governed architectural problem.

The frame therefore acts as the **organizing structure for standardization**.

10. One Frame, Multiple Architectures

The significance of the principle is ultimately its ability to separate **architectural structure** from **architectural content**.

The structure is:

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END 1 → INTERMEDIATE → END 2

The content changes.

HOPT-AS uses the frame for carbon-management pipeline topology.

HLAS uses the frame for hydrogen logistics.

NRIA uses the frame for nuclear repowering interfaces.

NEIA uses the frame for reactor-to-application integration.

The four architectures therefore do not need to resemble one another technically.

They need only conform to the underlying architectural logic established by the Three-Point Architecture Principle.

11. Conclusion

Standardization begins with the recognition that fundamental architectural decisions should not have to be reinvented for every project.

Novonanmek's response is to establish a common architectural frame:

END 1 → INTERMEDIATE → END 2

This is the **Three-Point Architecture Principle**.

The principle does not prescribe the technology or engineering solution. It establishes the structural frame within which those solutions are defined.

The four Novonanmek frameworks—**HOPT-AS, HLAS, NRIA, and NEIA**—were subsequently developed using this common principle.

Each framework defines its own architectural occupants, classifications, interfaces, relationships, compatibility requirements, and compliance rules.

The underlying frame remains constant.

The fundamental architecture of standardization can therefore be expressed simply:

The Principle defines the Frame.
The Framework defines the Architecture within the Frame.
The Rules govern the Architecture.

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This provides a deliberate and repeatable methodology for developing standardized architectures across different technical domains without requiring the underlying technologies to be identical.

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