Future Directions of INCOSE: Strategic Evolution

Digital Engineering Context in Systems Engineering

Dr. Michael Watson
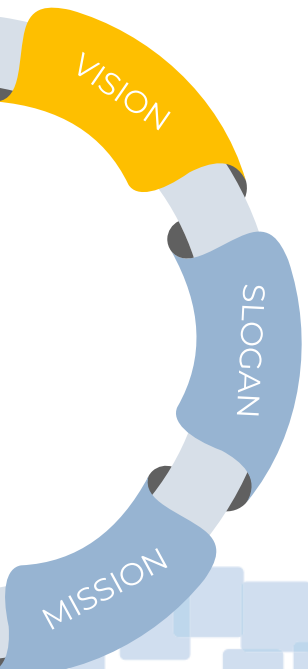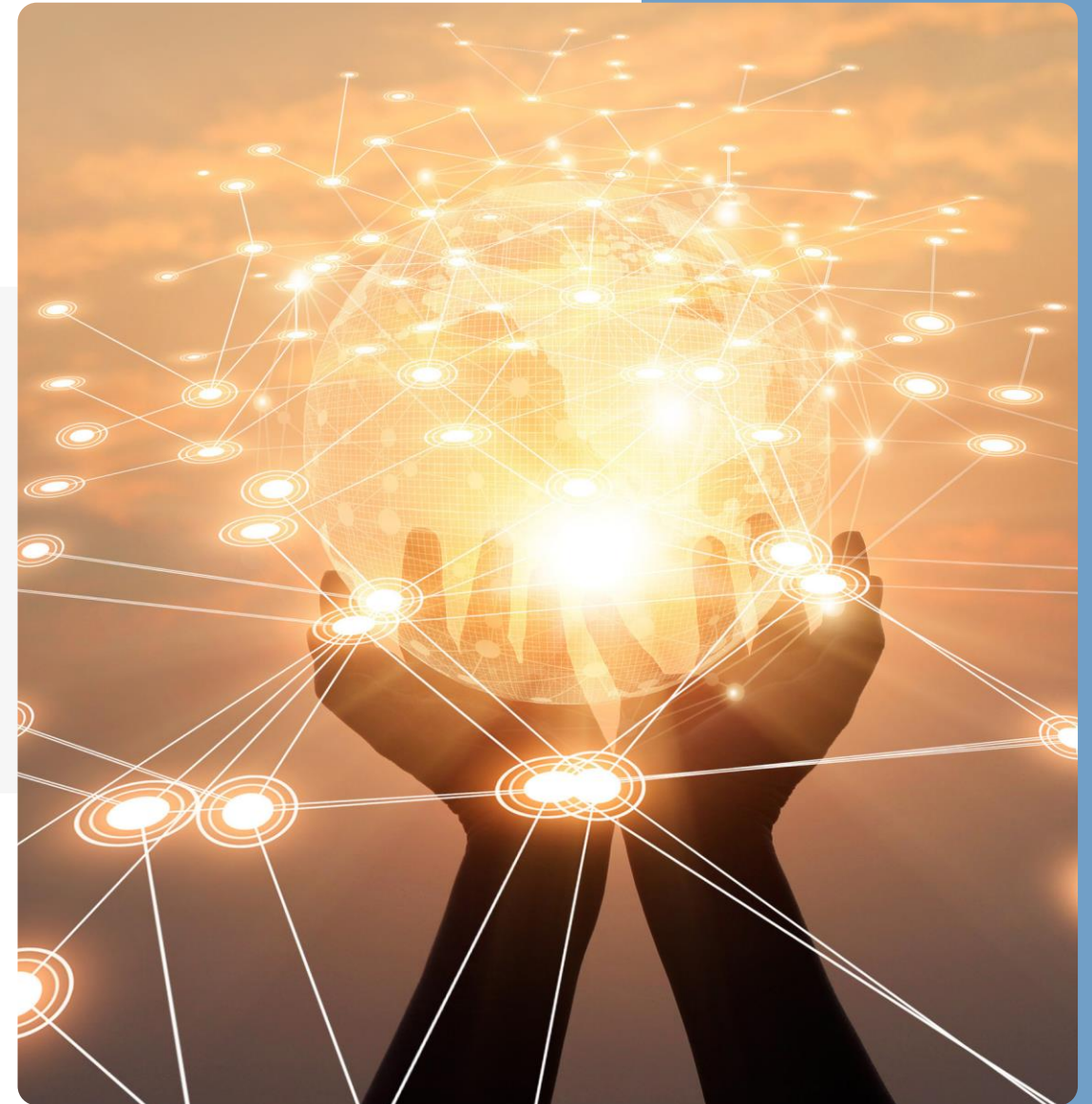
INCOSE President-Elect

Topics

- INCOSE Strategic Plan

- INCOSE Board Evolution

- System Modeling in Digital Engineering

Strategic Plan

A New Vision

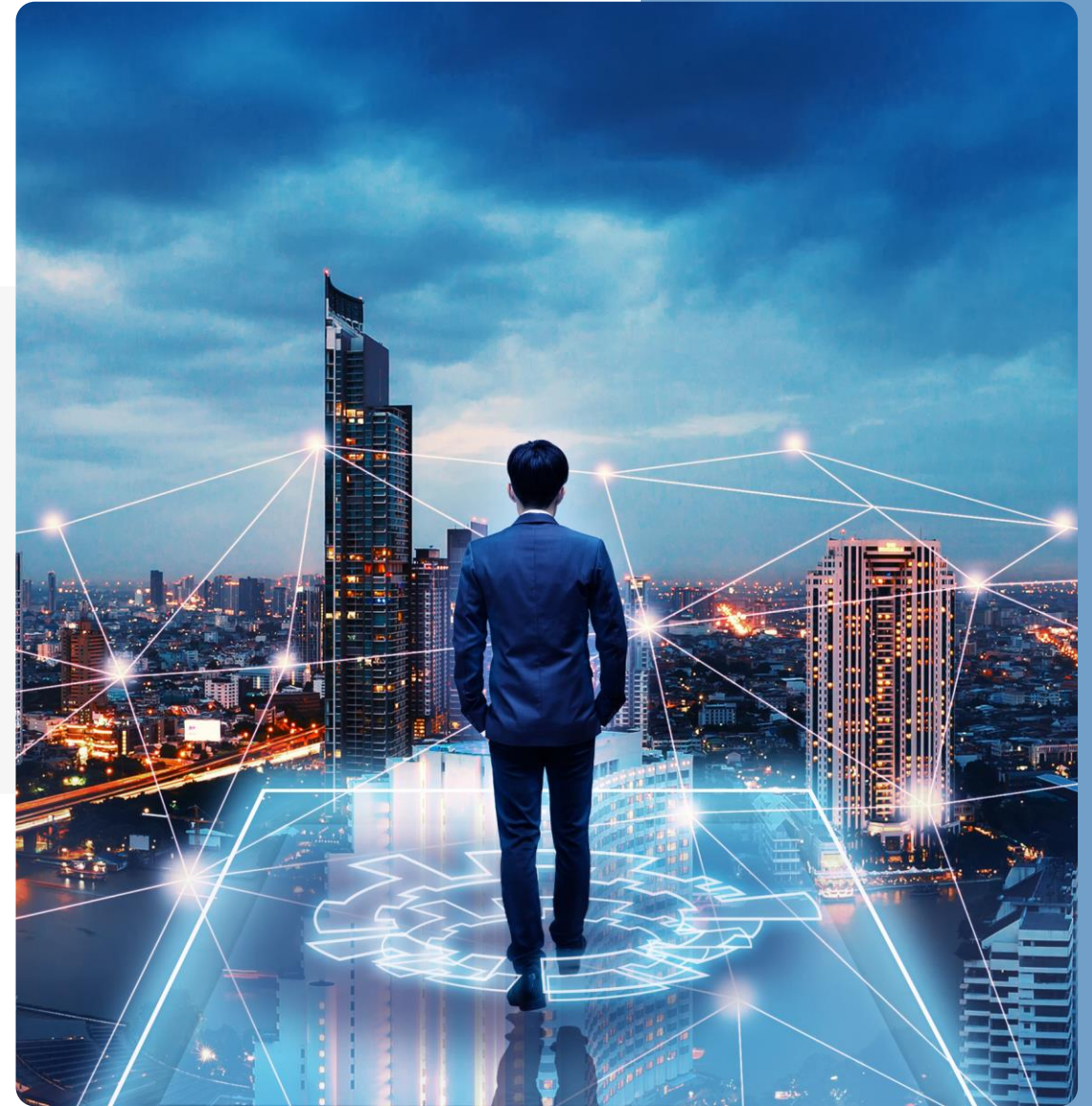To unite and advance the global systems community
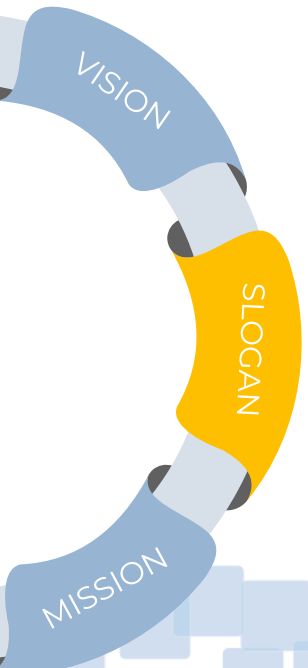
VISION

SLOGAN

MISSION

The INCOSE Slogan

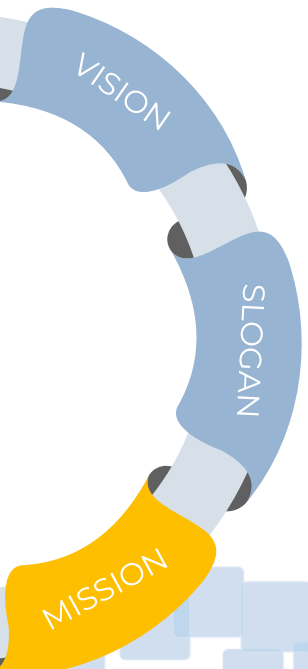A better world through a systems approach

VISION

SLOGAN

MISSION

The INCOSE Mission

INCOSE fosters systems engineering knowledge exchange, application, education, and research.

We are dedicated to being the world's trusted authority and forum for the practice, science, and art of systems engineering.

VISION

SLOGAN

MISSION

Advance systems engineering as the world's trusted authority

Expand the systems engineering community while growing INCOSE

Foster professional development and systems engineering competencies

Achieve operational excellence

Advance systems engineering as the world's trusted authority

- Create the future of systems engineering and mature its foundation by aligning roadmaps, initiatives, and strategic partnerships

- Connect, broker, publish, and endorse standards, products, and guides from professional societies and standards bodies reflecting the best in systems engineering

- Develop a coordinated portfolio of international, regional, and local events targeted to domains, topics, and competency levels

4

3

2

1

Satisfaction of / progress against future of systems engineering roadmap

Total unique delegates at international, regional, and local events

INCOSE

8

Expand the systems engineering community while growing INCOSE

- Promote the why, what, and value of systems engineering and those who apply it

- Develop targeted alliances to connect, leverage, and amplify the broader systems community and the collective set of systems approaches

- Attract individuals and organizations in targeted application domains, geographic areas, and organizational scales

- Engage new members making individuals and organizations an effective part of the INCOSE network from day one

Growth in membership in strategic focus regions

Number of unique organizations employing INCOSE members

4

3

2

1

Foster professional development and systems engineering competencies

- Execute a strategic publication, packaging, and curation plan addressing systems engineering principles, concepts, processes, methods, and tools to maximize discoverability, value, and impact of systems engineering knowledge

- Establish impactful services to address competency and career needs for systems practitioners throughout their career

- Create products and services to support the assessment and advancement of organizational proficiency in systems engineering

4

3 Total number of product accesses / services consumption

2 Number of systems engineering professionals (ESEP, CSEP, and ASEP)

1

10

Achieve operational excellence

* ❄ Advance a One INCOSE mindset

* ❄ Rearchitect INCOSE to achieve INCOSE's current and future objectives

* ❄ Develop frameworks and supporting infrastructure for efficient and effective chapter and working group operations

* ❄ Evolve and advance IT, communication, and marketing as shared services addressing member, leader, chapter, and organizational needs

4

3

2

1

"Leadership pulse" quarterly survey

Satisfaction of INCOSE's Annual Operating Plan

Board Evolution
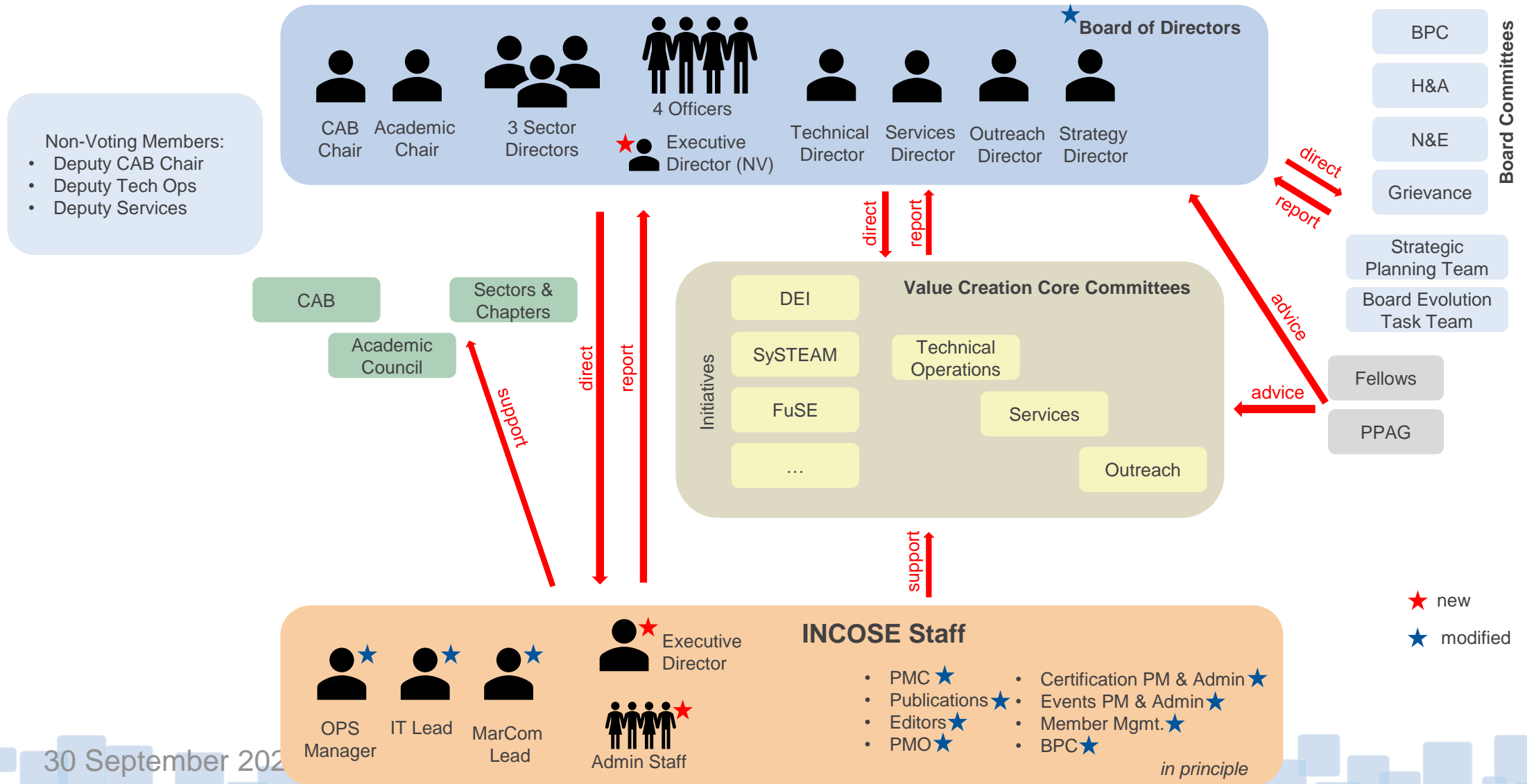
Strategic Planning

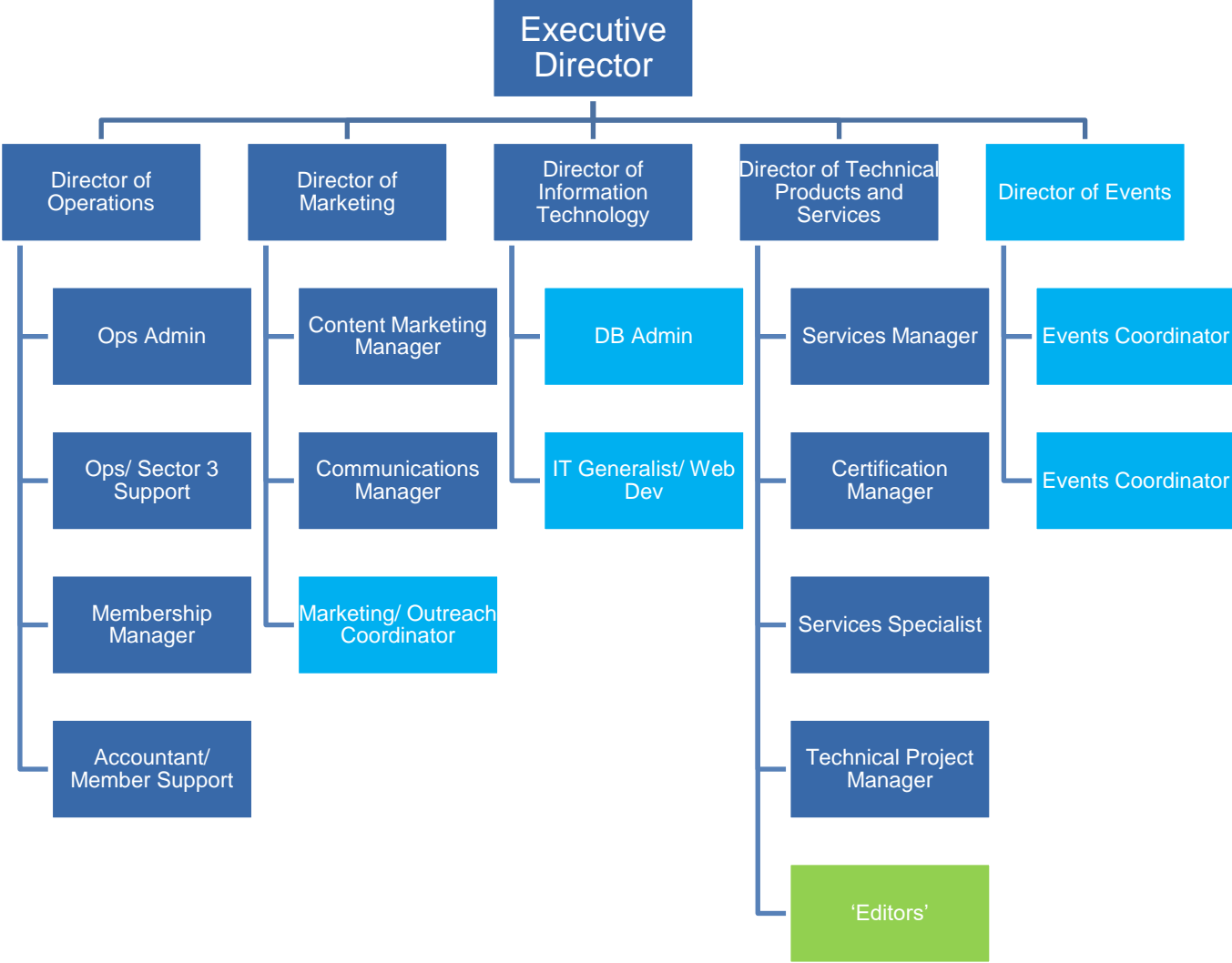
The seeds of this evolution were sown years ago
- – Understanding of the challenges born on volunteer leaders
- – Desiring a sustainable mechanism to support INCOSE and maintain growth
- – Foresight on the need for professional staff

Governance Organization (IW24)

INCOSE Staff Organization Structure

Board Evolution

- Work being accomplished is following best practices and benchmarks for global professional associations

- INCOSE will continue to be Board directed and led

- Staff will support and execute

- Leaders, volunteers and staff will work together to achieve our objectives and to deliver benefit to our members and discipline.

Board Evolution

Transition Point

INTERNAL, OPERATIONAL FOCUS → EXTERNAL, STRATEGIC FOCUS →

Strategic Capacity

Stage 1 Founding	Stage 2 Organizing	Stage 3 Double-Hatter	Stage 4 Transitional	Stage 5 Single-Hatter	Stage 6 Visionary
"Disorganized, Driven, Doers"	"Do and Document"	Board members chair committees	Strategic and Operational	Only wear governance hats	Creative, innovative and strategic

Digital Engineering in System Modeling

Digital Engineering

- Digital Engineering is the conduct of engineering based on models and simulations across all engineering disciplines
  - An integrated digital approach that uses authoritative sources of systems ' data and models as a continuum across disciplines to support lifecycle activities from concept through disposal. [1]
- Integration of these digital models has a number of approaches
  - Fully interactive models
    - Requires Application Program Interface for all modeling and simulation tools, common data formats, coordinated execution times (i.e., real time, slower than real time, faster than real time)
  - Relational Database
    - Key parameters are input by each model in a database on a regular basis
  - Multidisciplinary Design Optimization (MDO) tools are available which can interconnect various models

[1] Digital Engineering Strategy, 2018

Digital Engineering Terminology

- Digital Engineering Ecosystem
  - Interconnects the Digital Engineering infrastructure, environment, and methodology (process, methods, and tools) used to store, access, analyze, and visualize evolving systems' data and models to address the needs of the stakeholders. End to end digital enterprise. [1]
- Digital Thread
  - An extensible and configurable analytical framework that seamlessly expedites the controlled interplay of technical data, software, information, and knowledge in the digital engineering ecosystem, based on the established requirements, architectures, formats, and rules for building digital models[2]
- Digital Twin
  - An electronic representation - digital representation – of a real world entity, concept, or notion, either physical or perceived[3]
  - An abstract representation of a system
    - INCOSE Systems Engineering Principle 5
  - A fully representative digital twin is limited by computing power, model and simulation interfaces, execution times, etc.

[1] Department of Defense Digital Engineering Fundamentals
[2] Defense Acquisition University Definition
[3] Digital Twin Assessment, Agile Verification Processes, and Visualization Technology, 2022

Digital Engineering (DE)/Model Based Systems Engineering (MBSE)

- INCOSE has a strong MBSE community
  - How do we grow this community?
  - How do we connect this community more directly into Process Enablers, Application Domains, Analytic Enablers?
  - How do we best structure conferences, International Workshop (IW), International Symposium (IS) to support DE/MBSE?

System Models

- System Models are important to gain understanding of the System and Technology Application
  – Systems Engineering Principle 11(a): Systems engineering obtains an understanding of the system

- System Models convey information at the system level
  – Complementary to discipline-based engineering models

  – Integrate system functions and relationships within the system context
    • Systems Engineering Principle 8(a): Systems engineering seeks a best balance of functions and interactions within the system budget, schedule, technical, and other expectations and constraints.

  – Provide a relationship of the system capabilities to the stakeholder expectations

  – Provide a system context to understand integration of new technology capabilities

  – Provide a technical systems basis for system operations and maintenance functions, approaches, and procedures

- Remember models are abstractions of the system
  – Systems Engineering Principle 5: The real system is the perfect representation of the system.

System Model Types

- System Modeling is based on a set of system models rather than a single system model

- System Modeling Types
    1. Relational
        - SysML
        - Discrete Event Simulation (DES)
        - Requirements Management

    2. Physics-Based
        - Multidisciplinary Design Optimization (MDO)
        - Integrating Physics

    3. State Variable
        - Goal Function Tree (GFT)
        - State Analysis Model (SAM)

    4. System Value

    5. Statistical
        - Frequency Based
        - Bayesian
        - Information Theoretic

    6. System Dynamics

References

- INCOSE Systems Engineering Handbook
  - https://www.incose.org/publications/se-handbook-v5

- INCOSE Systems Engineering Principles
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- NASA Technical Publication: *Engineering Elegant Systems: Theory of Systems Engineering*
  - https://www.nasa.gov/wp-content/uploads/2018/09/nasa_tp_20205003644_interactive2.pdf

- NASA Technical Publication: *Engineering Elegant Systems: The Practice of Systems Engineering*
  - https://ntrs.nasa.gov/api/citations/20205003646/downloads/NASA_TP_20205003646_interactive.pdf

Thank you!

Questions?

www.incose.org