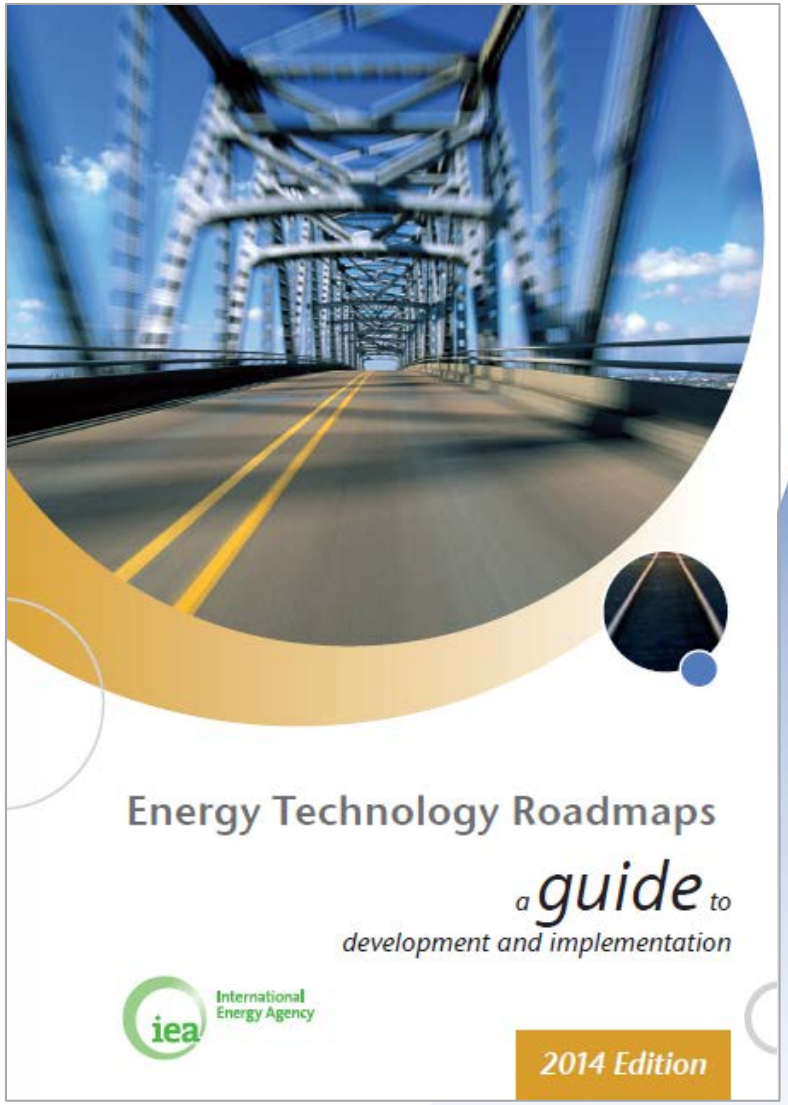
Roadmapping Breakout Session Overview

Ken Goodrich

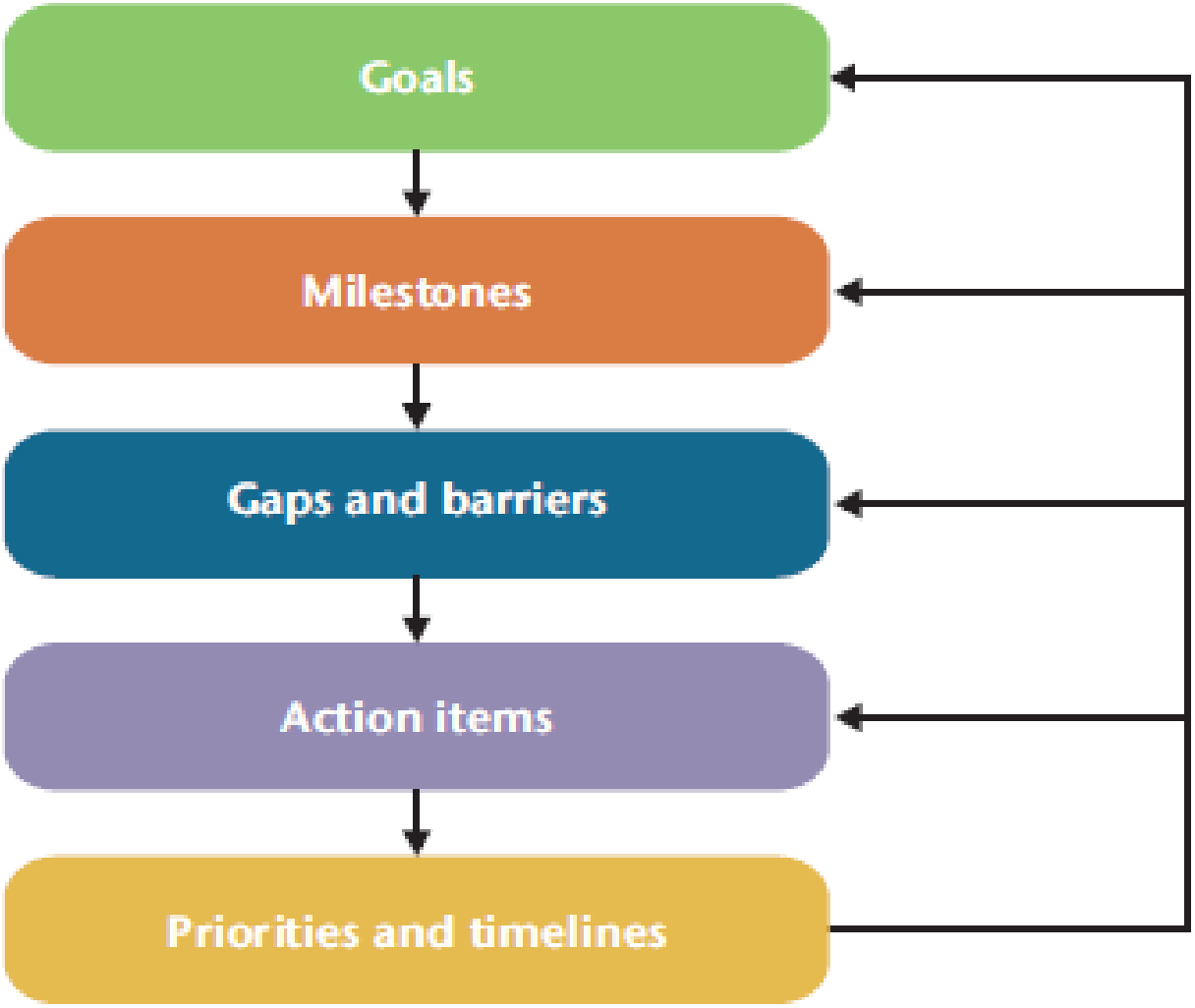
October 22, 2015

Definition

Roadmap: a specialized type of strategic plan that outlines activities an organization can undertake over specified time frames to achieve stated goals and outcomes.



Roadmap Elements



Roadmap Elements, cont.

Goals: a clear and concise set of targets that, if achieved, will result in the desired outcome; quantified goals (e.g. "improve energy efficiency in commercial buildings by 25% in ten years") provide the most specific guidance.

Milestones: the interim performance targets for achieving the goals, pegged to specific dates (e.g. "improve the energy efficiency of commercial buildings by 2% per year during the next five years without slowing economic growth").

Gaps and barriers: a list of any potential gaps in knowledge, technology limitations, market structural barriers, regulatory limitations, public acceptance or other barriers to achieving the goals and milestones.

Action items: actions that can be taken to overcome any gaps or barriers that stand in the way of achieving the goals; typical solution actions include technology development and deployment, development of regulations and standards, policy formulation, creation of financing mechanisms, and public engagement.

Priorities and timelines: a list of the most important actions that need to be taken in order to achieve the goals and the time frames, taking into account interconnections among those actions and stakeholder roles and relationships

Roadmap Elements, cont.

Goals: a clear and concise set of targets that, if achieved, will result in the desired outcome; quantified goals (e.g. "improve energy efficiency in commercial buildings by 25% in ten years") provide the most specific guidance.

Milestones: the interim performance targets for achieving the goals, pegged to specific dates (e.g. "improve the energy efficiency of commercial buildings by 2% per year during the next five years without slowing economic growth").

Gaps and barriers: a list of any potential gaps in **knowledge**, **technology** limitations, **market** structural barriers & **economics**, **regulatory limitations**, **public acceptance** or other barriers to achieving the goals and milestones.

Action items: actions that can be taken to overcome any gaps or barriers that stand in the way of achieving the goals; typical solution actions include technology development and deployment, development of regulations and standards, policy formulation, creation of financing mechanisms, and public engagement.

Priorities and timelines: a list of the most important actions that need to be taken in order to achieve the goals and the time frames, taking into account interconnections among those actions and stakeholder roles and relationships

Goals for Today's Breakout Sessions

- **Build on priorities expressed during yesterday afternoon's group discussion**
- **Breakouts for EP, SVO, and Other**
- **3 x 30 minute sessions for participation in multiple topics**
  - Encouraged to rotate, but may repeat
- **Process**
  - Facilitators briefly surmise previous sessions
  - Clarify goals, milestones, gaps & barriers as needed (~5 minutes)
  - Primary focus is on identifying possible technical approaches and supporting actions (e.g. studies) and pre-competitive products (~15 minutes)
  - Briefly consider desired (but realistic) timeframe for key products (~5 minutes)
  - Today's focus on capturing action space of participants; refinement comes later
  - Express dissent but allow majority to continue

Questions / Comments ?

Simplified Vehicle Operations Example Roadmap Decomposition

Ken Goodrich

October 22, 2015

Top-Level ODM Barriers & SVO

Current General Aviation (GA) Aircraft compared to Commercial Airliners

- **Poor Aerodynamic and Propulsive Efficiencies**
  - Aerodynamic efficiency measured as Lift/Drag ratio is 9-11 compared to 17-20.
  - (Thermal) x (propulsive efficiency) of 20-24% compared to 36-40%.
- **Poor Emissions**
  - High Hydrocarbon, Green House Gas emissions, particulates and lead pollution.
- **Poor Community Noise**
  - Similar levels and certification compliance with few improvements for the past 50 years.
- **Poor Comparative Safety**
  - **Accident rate 56x worse than airlines, 15x worse than autos per 100 million vehicle miles traveled**.
- **Poor Ride Quality**
  - Low wing loading leads to bumpy ride along with gust sensitivity. (Note, technology needed for SVO also applicable to active gust alleviation)
- **Poor Dispatch Reliability Rate**
  - Maintenance and weather sensitivity result in <70% rate for trip completion.
- **Substantially Higher Operating Costs**
  - Compared to all other transportation options (car, airline, train).
- **Onerous Training Requirements**
  - Currently only 0.18% of the U.S. population is capable of flying GA aircraft compared to 69% who have a driver's license.

SVO Roadmap: Goals

- **Flight systems, interfaces, and operations that make ODM aviation as accessible and practical as driving + safer**
- **Simplified control of conventional and novel aircraft configurations**
- **Approach aligned with developing and operationally proving technologies beneficial to transport and other aviation operations**

SVO System Elements

- **Pilot**
- **Aircraft and systems**
- **Remote support (e.g. dispatch, ground-pilot)**
- **Airspace System & Operations**
  - Relatively inflexible in the near-term
  - Must design for the present and possible futures
  - Some near-term operational simplification possible by limiting navigation and operation options (…with some negatives)

Proposed SVO Work Breakdown Structure

- 1) System concepts, integration, and evaluation
- 2) Augmented Flight Path Control
- 3) Autonomous vehicle awareness, hazard avoidance
- 4) Decision support for flight management
- 5) Ultra-reliable, part 23 systems
- 6) Remote flight and decision support

- A) Airspace Operations , ATC interaction
- B) Pilot certification and training

Milestones: 3 SVO Epochs, 10 years?

- **SVO-1,** (2016-2026): **Foundational Precedents & Capabilities**
- **SVO-2:** (2021-2036): **SPC, Simplified Pilot Certificate**
- **SVO-3,** (2031-2051): **Autonomous Operations,**

Milestones: 3 Epochs of SVO

SVO-1: Foundational Precedent and Supporting Capabilities

- Demonstrate transition of key skill/capability from pilot to aircraft
  - E.g., Simplified path control
- Moderate workload peaks and specialized skills
- Mitigate pilot as single-point of failure (…automation back-stops pilot)
- Other considerations:
  - Expect only incremental airworthiness certification accommodation, but lays foundation for future
  - Current FAA training required (e.g. ab initio-to IFR in minimum of 70 hours with combined private-instrument curriculum), but new pilots capable of more confident, near-all weather ops.
  - Benefits/grows thin-haul, air taxi, current and early adopter private-pilot markets
  - Operational experience for SVO-2, Part 121, and UAS applications
  - Operate within current and planned NextGen Airspace

Milestones: 3 Epochs of SVO

SVO-2 (2021 – 2036): SPC, Simplified Pilot Certificate

- Simplified training & licensing based on research and operational experience from SVO-1
- Regulatory changes to knowledge, training, and experience requirements
  - Goal ab initio to near-all weather pilot in <40 hours (similar to driver training)
  - Reduced training, experience requirements for Thin-Haul pilots
- New flight system, interfaces, and operation standards that allow updates to training and operational regulations in Part 61, 91, and 135 taking full advantage of technology
  - E.g. possible expansions to Part 135 operations
- Initial airspace accommodations for simpler & higher-volume operations
  - Automated management of non-towered airports
  - More frequent use of data comm.

Milestones: 3 Epochs of SVO

SVO-3 (2031 - 2051): Autonomous Operations

- Combination of aircraft and any off-board board support shoulder command responsibility; nominally accommodates user direction, but may modify or inhibit if deemed unsafe or disruptive

- Vehicle, automation, and airspace fully integrated
  - >>10x current operations
  - Runway independent operations very common
  - No need for voice communication

Example SVO-1, Gaps and Barriers

- Knowledge
- Standards
- Regulatory
- Economic
- Public acceptance

Example SVO-1, Gaps and Barriers

- **Knowledge**
  - Optimal roles, responsibilities, interfaces for simplified path control, systems, and mission management
  - Autonomous situation awareness, decision support, hazard protection with CRM-like interaction
    - E.g. context aware including own limits,
  - Ultra-high integrity, available systems with graceful degradation
  - Alternate systems for safe recovery (e.g. ballistic chute)
  - Aids to simplify interactions with current and planned ATM system
- **Standards**
- **Regulatory**
- **Economic**
- **Public acceptance**

Example SVO-1, Gaps and Barriers

- **Knowledge**
- **Standards**
  - Design & flying qualities standards for simplified path control, normal and degraded modes
  - SVO equivalent of Basic-T & GAMA Publication #10
  - Standard architecture & AC23.1309 analysis
  - Minimum operatizing performance standards avionics
- **Regulatory**
- **Economic**
- **Public acceptance**

Example SVO-1, Gaps and Barriers

- **Knowledge**
- **Standards**
- **Regulatory**
  - Certification standards for core capabilities
  - Modified training and operational regs.
- **Economic**
- **Public acceptance**

Example SVO-1, Gaps and Barriers

- **Knowledge**
- **Standards**
- **Regulatory**
- **Economic**
  - Reusable, open architecture/design for flight-critical systems, reduced non-recurring development costs
- **Public acceptance**

Example SVO-1, Gaps and Barriers

- **Knowledge**
- **Standards**
- **Regulatory**
- **Economic**
- **Public acceptance**
  - Traveling demonstration for travel and transportation trade-shows

Summary

- **Examples only—not constraints**
- **Time today is limited**
  - Big picture, avoid weeds
  - Will flesh-out post workshop
- **Questions?**