

Lecture 07 - Contents

An overview of the parts in the medical AI agents lecture.

Part 1

Agent Fundamentals

Part 2

Multi-Agent Systems

Part 3

Clinical Workflows

Hands-on

Agent Building Hands-on

This outline is for guidance. Navigate the slides with the left/right arrow keys.

Lecture 7:

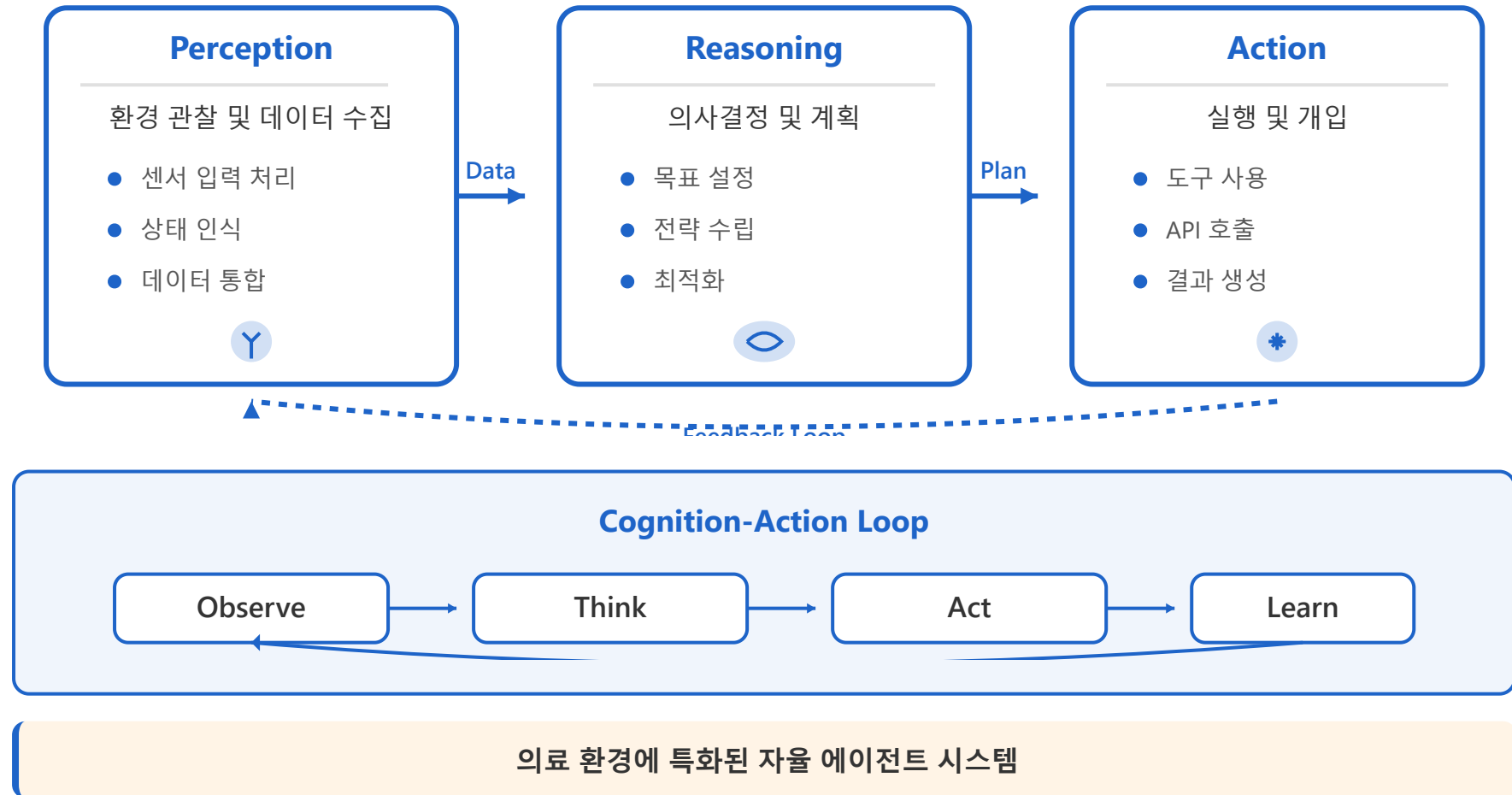
Agentic AI: Autonomous Medical Assistants

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Agent Architecture Overview

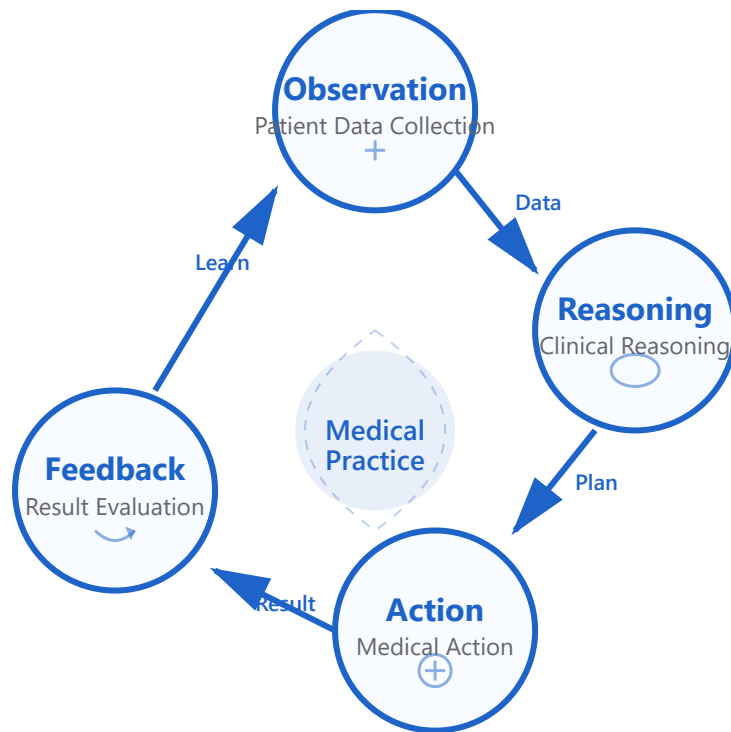


Part 1/3:

Medical Agent Fundamentals

1. Perception-Action Loops
2. Medical Tool Use
3. EHR API Integration
4. Lab System Interfaces
5. Drug Database Access
6. Medical Calculator Tools
7. Clinical Guideline Agents

Perception-Action Loops



Observation

Patient Data Collection

- Real-time Monitoring
- Symptom Observation
- Test Result Verification

Reasoning

Clinical Reasoning

- Symptom Analysis
- Diagnostic Hypothesis
- Treatment Plan

Action

Medical Action

- Prescription Writing
- Test Ordering
- Treatment Intervention

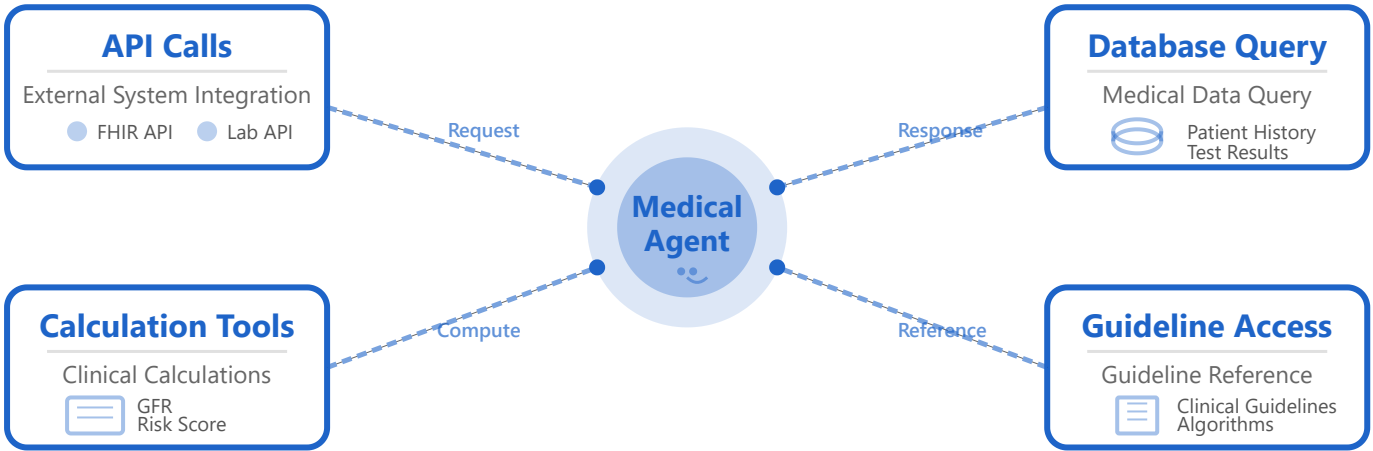
Feedback

Result Evaluation

- Effect Verification
- Side Effect Monitoring
- Plan Adjustment

Continuous Learning Loop in Medical Practice

Medical Tool Use



API Calls

External System Integration

- FHIR API
- Lab System API
- Drug DB API

Database Query

Medical Data Query

- Patient History
- Test Results
- Drug Information

Calculation Tools

Clinical Calculations

Guideline Access

Guideline Reference

- GFR Calculation
- Risk Score
- Drug Dosing

- Clinical Guidelines
- Drug Interactions
- Algorithms

EHR API Integration

FHIR API

Standard medical information exchange

- Patient Resource
- Observation Resource
- Medication Resource

Read Access

Patient data retrieval

- Demographics
- Diagnosis history
- Medication records

Write Access

Data creation/modification

- Medical records
- Prescription orders
- Test requests

Security & Authorization Required

Lab System Interfaces

LIS Connection

Laboratory System Integration

- Order Transmission
- Result Reception
- Status Check

Test Ordering

Test Order Creation

- Test Selection
- Priority Setting
- Specimen Information

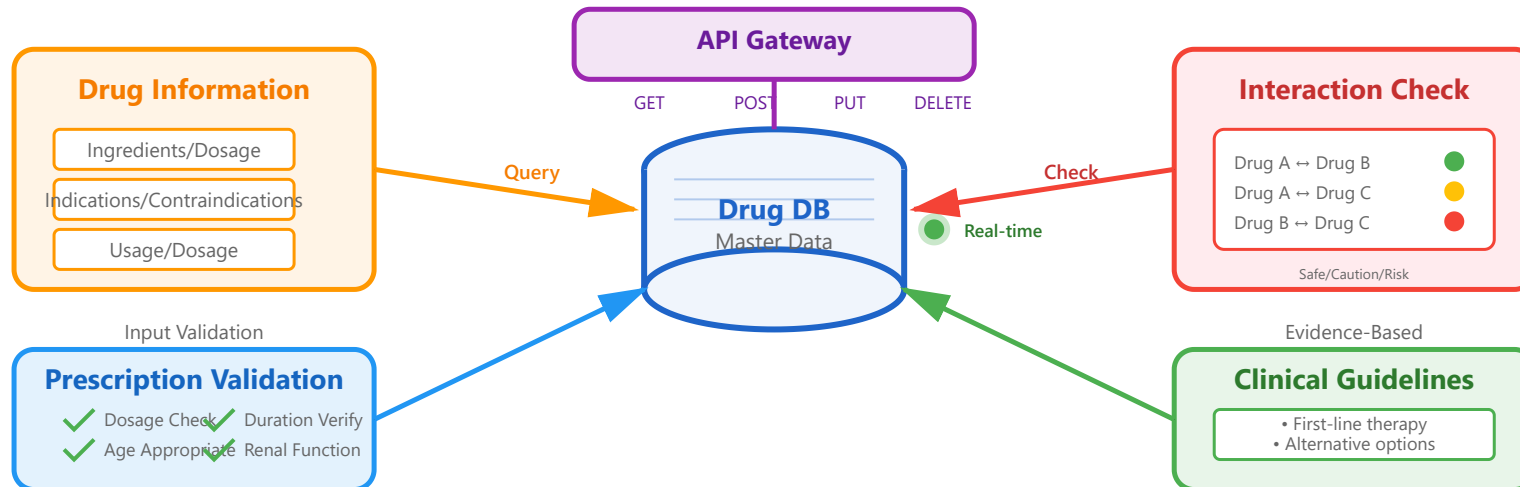
Result Retrieval

Result Viewing

- Automatic Reception
- Notification Processing
- Abnormal Value Detection

Drug Database Access

Drug Database Integration System



Drug Information

- Ingredients & Content
- Indications/Contraindications
- Usage/Dosage Guidelines
- Side Effect Information

Interaction Check

- Drug-Drug Interactions
- Drug-Food Interactions
- Risk Assessment
- Alternative Drug Suggestions

Prescription Validation

- Dosage Appropriateness
- Duration Verification
- Age-Based Adjustment
- Renal/Hepatic Considerations

Medical Calculator Tools

Renal Function

- eGFR
- CrCl (Cockcroft-Gault)
- MDRD

Risk Scores

- CHADS2-VASc
- GRACE Score
- APACHE II

Drug Dosing

- Weight-based
- Renal Adjustment
- Age-based

Clinical Guideline Agents

Guideline Retrieval

Latest guideline search

- Disease-specific guidelines
- Treatment algorithms
- Evidence levels

Recommendation

Personalized recommendations

- Patient characteristics considered
- Preference consideration
- Alternative suggestions

Update Monitoring

Guideline updates

- Change tracking
- Notification generation
- Reassessment

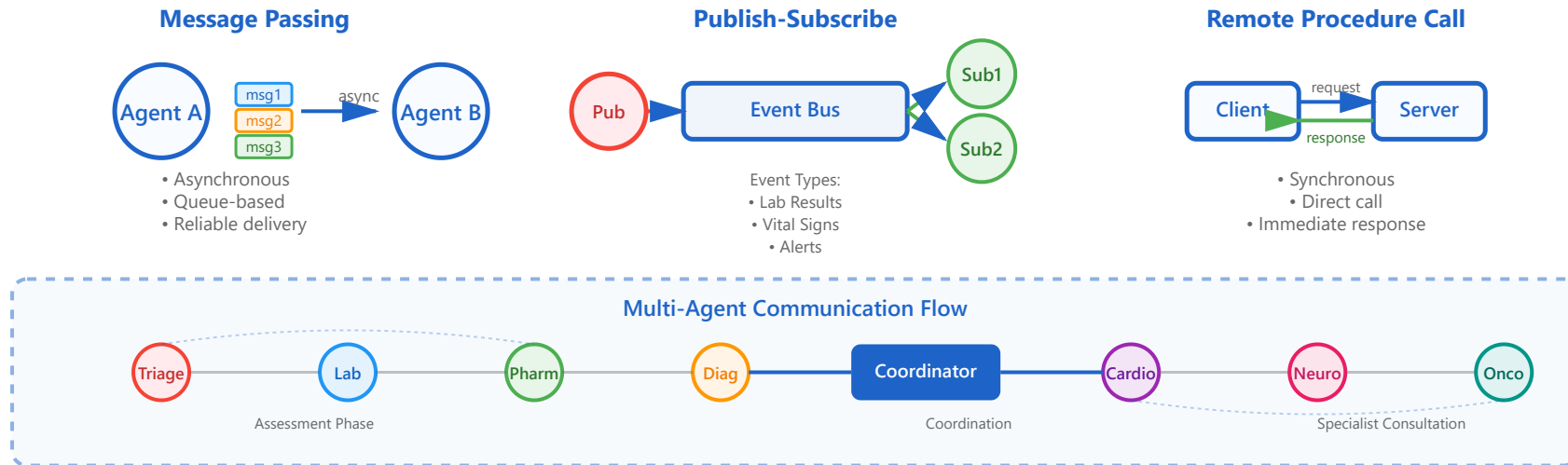
Part 2/3:

Part 2: Collaborative Multi-Agent Systems

1. Agent Communication Protocols
2. Collaborative Diagnosis
3. Specialist Agent Networks
4. Consensus Mechanisms
5. Task Delegation Strategies
6. Workflow Orchestration

Agent Communication Protocols

Medical Agent Communication Architecture



Message Passing

Asynchronous message delivery

- Queue-based delivery
- Guaranteed ordering
- Error handling
- Retry mechanism

Publish-Subscribe

Event-driven communication

- Event broadcasting
- Multiple subscribers
- Topic filtering
- Loose coupling

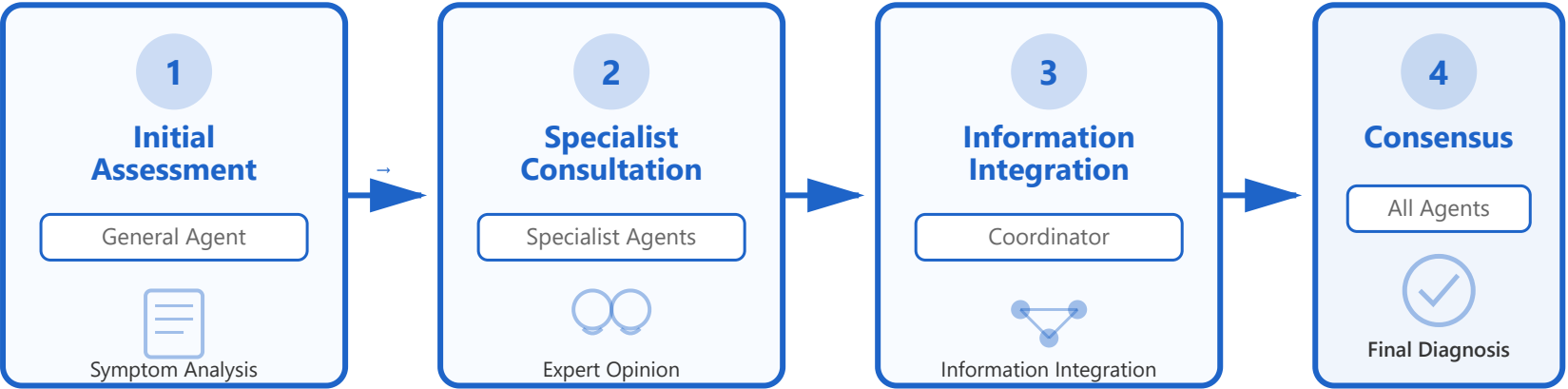
RPC

Remote procedure call

- Synchronous calls
- Direct response
- Type safety
- Error propagation

Collaborative Diagnosis

Multi-Agent Collaborative Diagnosis Workflow



1

Initial Assessment

General Agent
Symptom Analysis

2

Specialist Consultation

Specialist Agents
Expert Opinion

3

Information Integration

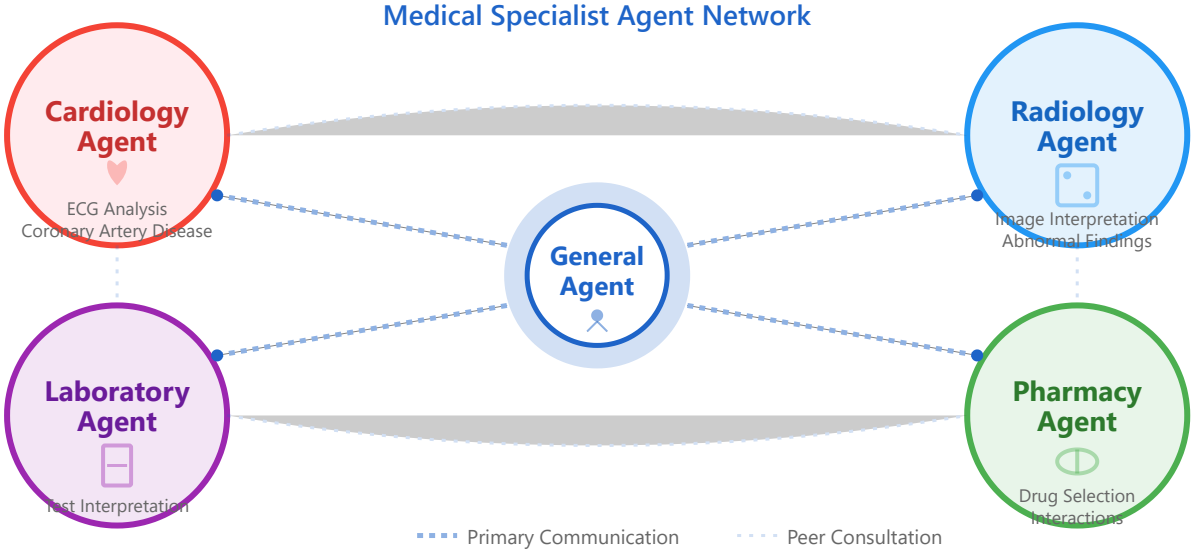
Coordinator
Information Integration

4

Consensus

All Agents
Final Diagnosis

Specialist Agent Networks



Cardiology Agent

- ECG Analysis
- Coronary Artery Disease
- Arrhythmia

Radiology Agent

- Image Interpretation
- Abnormal Findings
- Anatomical Assessment

Laboratory Agent

- Test Interpretation
- Abnormal Value Analysis
- Trend Analysis

Pharmacy Agent

- Drug Selection
- Interactions
- Dose Adjustment

Task Delegation Strategies

Capability-based

Allocation based on capability

- Expertise
- Availability
- Workload

Priority Queue

Priority-based

- Urgency
- Importance
- Dependencies

Load Balancing

Load distribution

- Workload
- Response time
- Resources

Task Delegation Strategies

Capability-based

Allocation based on capability

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Priority Queue

Priority-based

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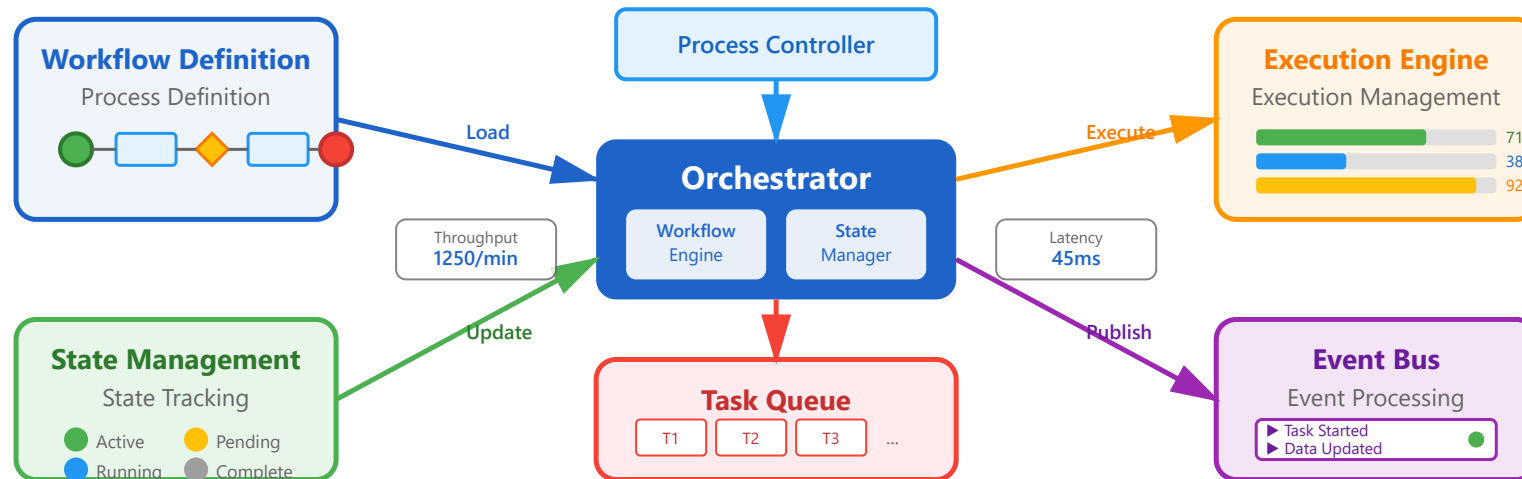
Load Balancing

Load distribution

- Workload
- Response time
- Resources

Workflow Orchestration

Clinical Workflow Orchestration Engine



Workflow Definition

Process Definition

- BPMN Modeling
- Conditional Branching
- Parallel Processing
- Event Triggers

Execution Engine

Execution Management

- Task Scheduling
- Resource Allocation
- Error Handling
- Retry Logic

State Management

State Tracking

- Real-time Monitoring
- State Transitions
- Audit Logs
- Recovery Points

Part 3/3:

Part 3: Clinical Workflow Automation

1. Patient Intake Agents
2. Clinical Pathway Automation
3. Medication Management Agents
4. Follow-Up Care Coordination
5. Quality Assurance Agents
6. Safety Monitoring Systems

환자 접수 에이전트

등록

- 신원 확인
- 보험 확인
- 동의서

주호소

- 주 증상
- 발생 시기
- 진행 경과

병력

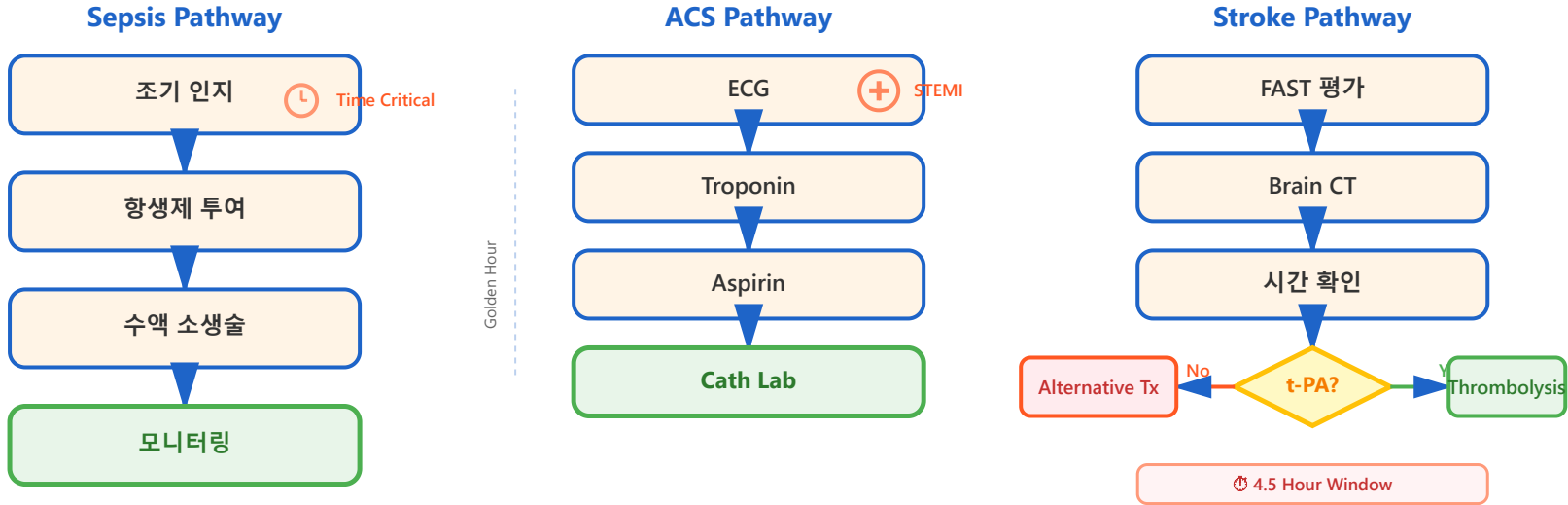
- 과거력
- 가족력
- 약물 이력

초기 평가

- 활력징후
- 초기 평가
- 긴급도 분류

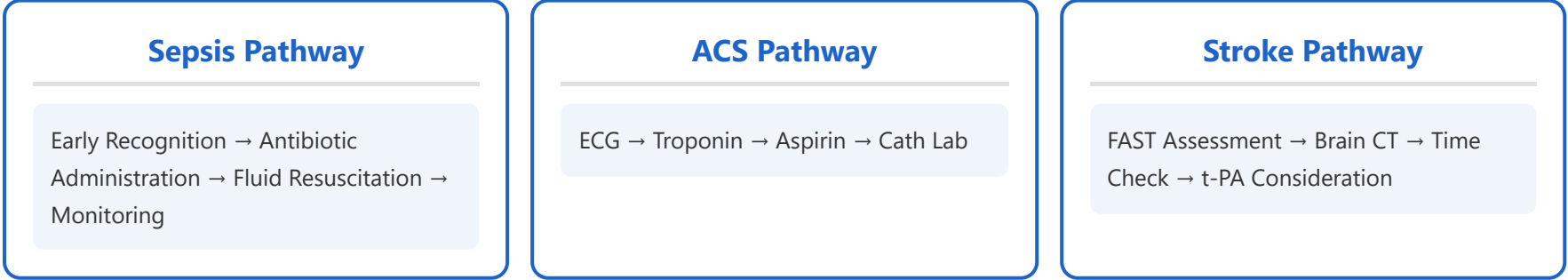
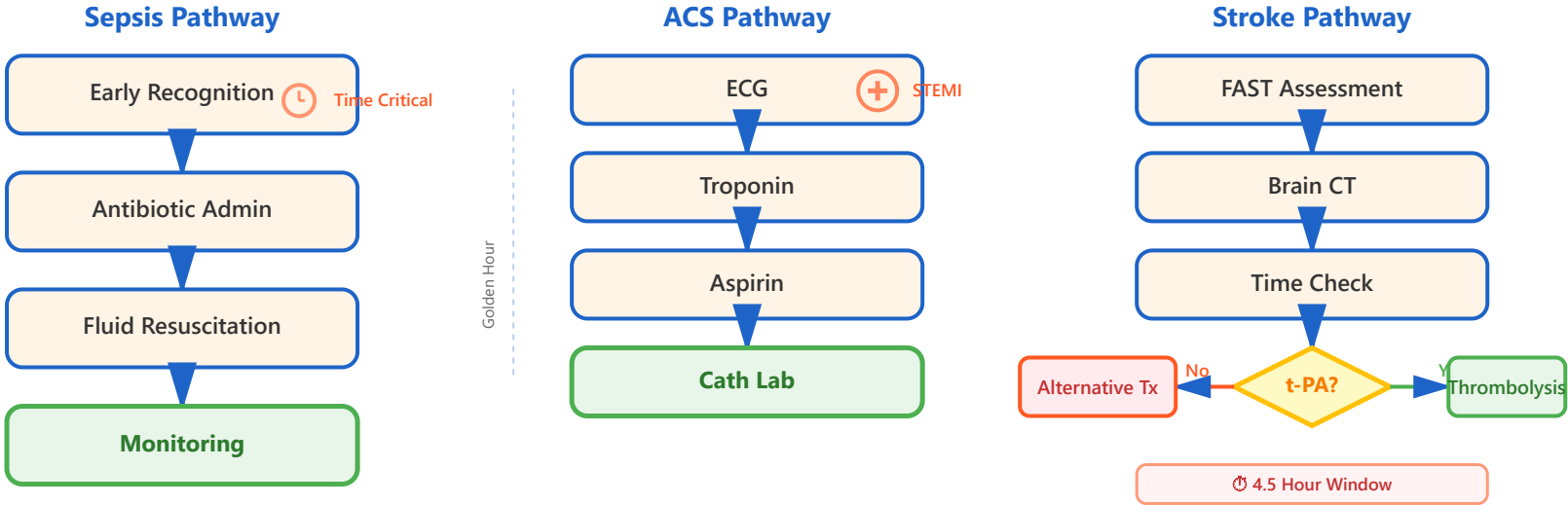
Clinical Pathway Automation

Automated Clinical Pathways



Clinical Pathway Automation

Automated Clinical Pathways



Follow-Up Care Coordination

Appointment Scheduling

- Follow-up Schedule
 - Automatic Booking
 - Reminders
 - Notification Settings
-

Automatically manages follow-up appointment schedules according to patient treatment plans and prevents no-shows through appointment reminders.

Test Follow-up

- Result Verification
 - Additional Testing
 - Abnormal Value Alerts
 - Trend Analysis
-

Tracks test results, sends immediate alerts when abnormal values are detected, and analyzes long-term health trends.

Care Transition

- Discharge Planning
 - Referral Management
 - Inter-department Coordination
 - Continuity Maintenance
-

Ensures continuity of care after discharge and supports seamless information sharing and referral management with other departments or external healthcare facilities.

Quality Assurance Agents

Process Metrics

- 대기 시간
- 처리 시간
- 완료율
- 병목 지점

Outcome Metrics

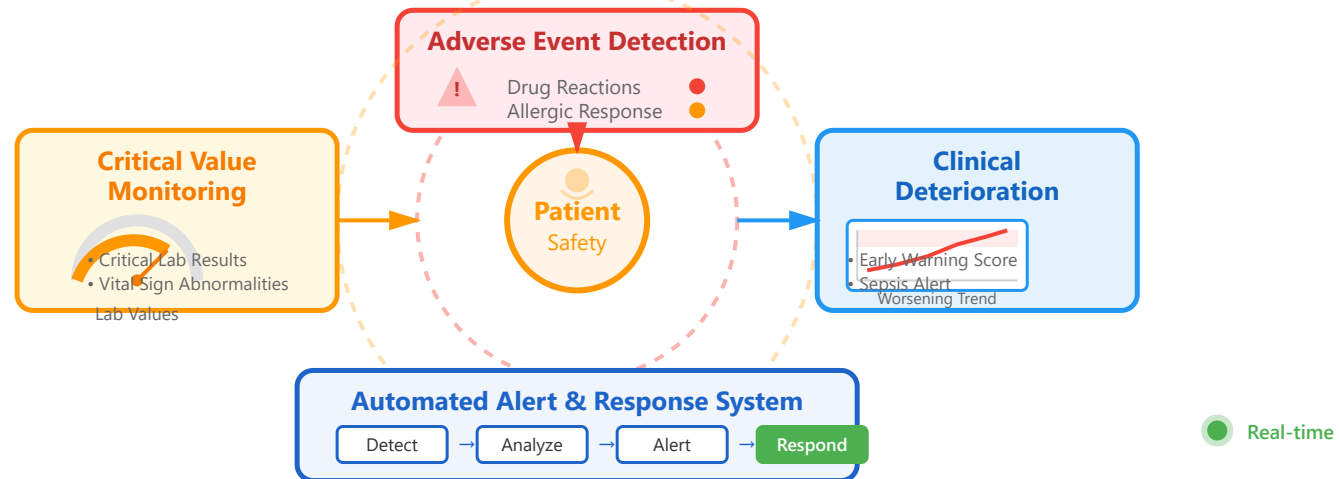
- 재입원을
- 합병증 발생
- 환자 만족도
- 치료 효과

Compliance Metrics

- 가이드라인 준수
- 문서화 완성도
- 안전 점검
- 인증 기준

Safety Monitoring Systems

Multi-Layer Patient Safety Monitoring



Adverse Event Detection

- Drug Adverse Event Detection
- Allergic Reactions
- Interaction Warnings
- Reporting System

Critical Value Monitoring

- Critical Lab Results
- Vital Sign Abnormalities
- Critical Imaging Findings
- Immediate Notification

Clinical Deterioration

- Early Warning Score
- Sepsis Alert
- RRT Criteria
- Rapid Response

Agent Evaluation Metrics

Performance

- Accuracy
- Precision
- Recall
- F1-Score

Measures how well the agent completes tasks correctly, including prediction accuracy, precision in identifying relevant information, recall in capturing all necessary elements, and balanced F1-score.

Efficiency

- Response Time
- Throughput
- Resource Usage
- Latency

Evaluates operational speed and resource optimization, tracking response time, task throughput, computational resource consumption, and system latency for optimal performance.

Reliability

- Uptime
- Error Rate
- Recovery Time
- Fault Tolerance

Assesses system stability and dependability through uptime monitoring, error frequency analysis, recovery speed after failures, and capacity to handle unexpected conditions.

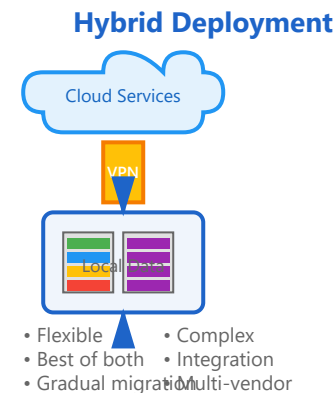
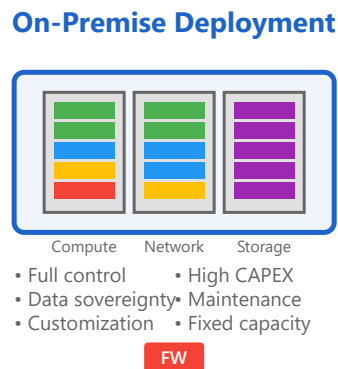
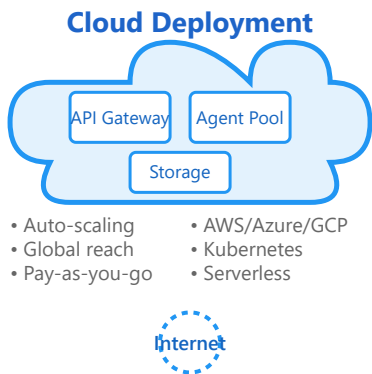
Safety

- Error Detection
- False Alarm Rate
- Clinical Impact
- Patient Safety

Ensures safe operation in critical environments by monitoring error detection capabilities, minimizing false alarms, evaluating clinical outcomes, and prioritizing patient safety standards.

Deployment Architectures

Medical AI Agent Deployment Options



Metric		Deployment Comparison Matrix			
	Cloud	On-Premise	Hybrid	Scalability:	
Initial Cost:	Low	High	Medium	Excellent	Limited
				Good	

Cloud

- ✓ Rapid deployment
- ✓ Auto-scaling
- ✓ Low initial cost
- ✓ Simplified management
- ✗ Data security concerns
- ✗ Network dependency
- ✗ Regulatory constraints
- ✗ Cost predictability

On-Premise

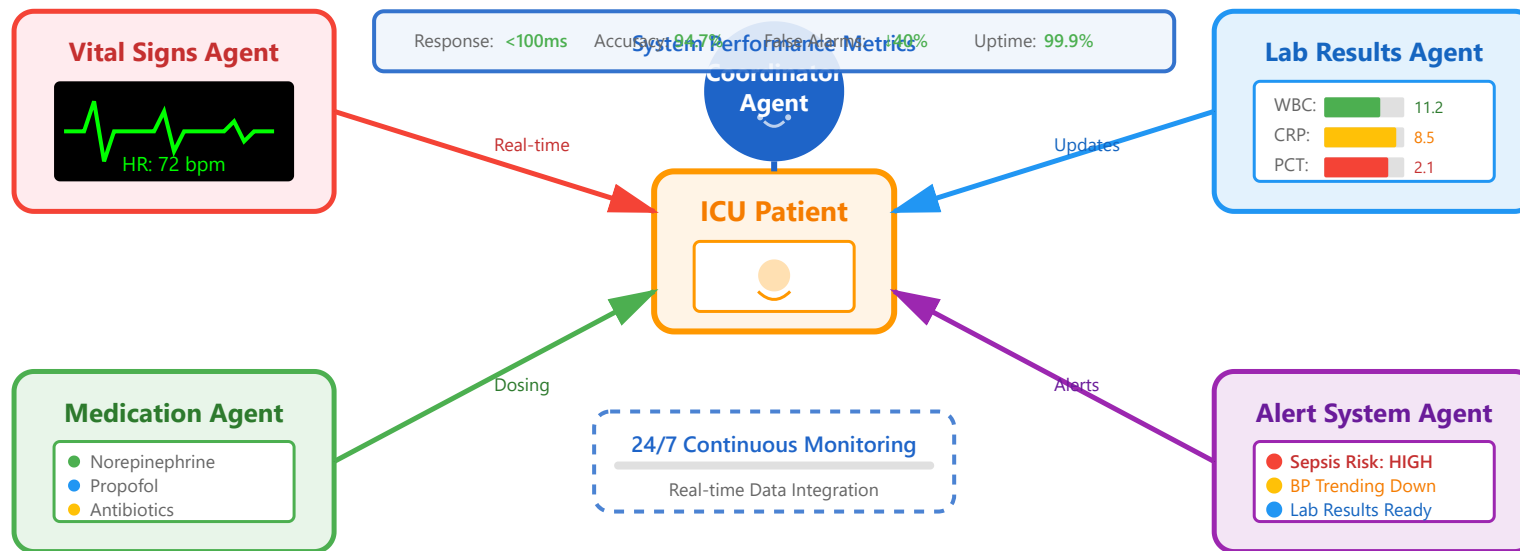
- ✓ Complete data control
- ✓ Enhanced security
- ✓ Customization
- ✓ Regulatory compliance
- ✗ High initial cost
- ✗ Maintenance burden
- ✗ Scalability limitations
- ✗ Infrastructure management

Hybrid

- ✓ Flexible architecture
- ✓ Gradual migration
- ✓ Diversified backup
- ✓ Optimization
- ✗ Complex integration
- ✗ Dual management
- ✗ Security boundaries
- ✗ Consistency challenges

Case Study: ICU Monitoring Agent

Multi-Agent ICU Monitoring System Architecture



Problem

- Need for real-time ICU monitoring and early warning system
- Increased medical staff burden and alarm fatigue
- Difficulty in integrating and interpreting complex data

Solution

- Multi-agent based integrated monitoring system development
- Real-time data analysis and pattern recognition
- Intelligent alarm filtering and prioritization

Implementation

- Real-time analysis integrating vital signs, lab results, and medication data
- Each specialized agent manages a specific domain
- Central coordinator performs comprehensive assessment and generates alerts

Results

- 30% improvement in early detection rate
- 40% reduction in false alarms
- Increased medical staff satisfaction and improved patient outcomes

Hands-On: Agent Building

LangChain

- Tool Integration
- Chain Composition
- Memory Management
- Prompt Templates

AutoGen

- Multi-Agent Framework
- Conversation Patterns
- Code Execution
- Collaboration

Custom Implementation

- Flexible Design
- Domain-Specific Logic
- Full Control
- Integration

Example Project

- Simple Medical Agent with EHR Access

Regulatory Considerations

FDA Regulation

- SaMD Classification
- Clinical Trial Requirements
- Approval Pathway
- Post-market Surveillance

Liability

- Clarification of Liability
- Medical Malpractice Insurance
- Scope of Indemnity
- Legal Review

Audit & Validation

- Detailed Logging
- Complete Traceability
- Regular Validation
- Performance Monitoring

Data Privacy

- HIPAA Compliance
- GDPR Compliance
- Personal Data Protection
- Data Encryption

Thank you

Lecture 7 Summary:

- Medical Agent Fundamentals
- Multi-Agent Collaboration
- Clinical Workflow Automation
- Deployment & Regulatory Compliance

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