# TIL: Pause and Resume Invocations with Google ADK 1.16.0

**Date:** 2025-10-20

**Difficulty:** intermediate

**Reading Time:** 10 minutes

**Tags:** til, quick-learn, pause-resume, adk-1.16, state-checkpointing, fault-tolerance, human-in-loop

**Description:** Quick guide to using Pause and Resume Invocations: checkpoint agent state and resume execution later for long-running workflows, human-in-the-loop, and fault tolerance

## TIL: Pause and Resume Invocations - Resilient Agent Workflows

### Why Pause/Resume Invocations Matter

**The Problem**: Long-running agent tasks need to be interrupted gracefully or paused for human feedback without losing progress. System failures can interrupt execution mid-task, causing work to be lost.

**In one sentence**: Pause and Resume Invocations let agents checkpoint their state at key points and resume execution later without losing context.

### Why Should You Care?

**Problems it solves:**

- 🛡️ **Fault tolerance** - System failures don't cause work loss; resume from checkpoint

- 👤 **Human-in-the-loop** - Agent pauses to request feedback, then continues
- ⏱️ **Long-running tasks** - Complex workflows can pause at natural break points
- 🔄 **Multi-agent handoff** - State is preserved when handing off between agents
- 💾 **State persistence** - Complete execution context is saved automatically

**Perfect for:**

- Data processing pipelines (batch jobs with checkpoints)
- Customer support escalations (pause for supervisor review)
- Research workflows (save progress between analysis steps)
- Approval workflows (pause for human decision-making)
- Resilient production systems (automatic recovery from failures)

## Quick Example

```python
from google.adk.apps import App, ResumabilityConfig
from google.adk.agents import Agent

# Create agent as usual
agent = Agent(
    name="long_task_agent",
    model="gemini-2.0-flash",
    description="Agent for long-running tasks",
    instruction="Complete tasks with checkpoints."
)

# Enable pause/resume support
app = App(
    name="resumable_app",
    root_agent=agent,
    resumability_config=ResumabilityConfig(is_resumable=True)
)

# Initial invocation - creates checkpoint on agent completion
async for event in runner.run_async(session=session, new_message=user_input):
    last_invocation_id = event.invocation_id
    # Event includes: end_of_agent=True, agent_state={...}

# [Later] Resume from checkpoint with new input
async for event in runner.run_async(
    session=session,
    new_message=new_input,
    invocation_id=last_invocation_id  # Resume from here!
):
    # Execution continues from saved checkpoint
    pass
```

## How It Works (3 Key Concepts)

### 1. State Checkpointing

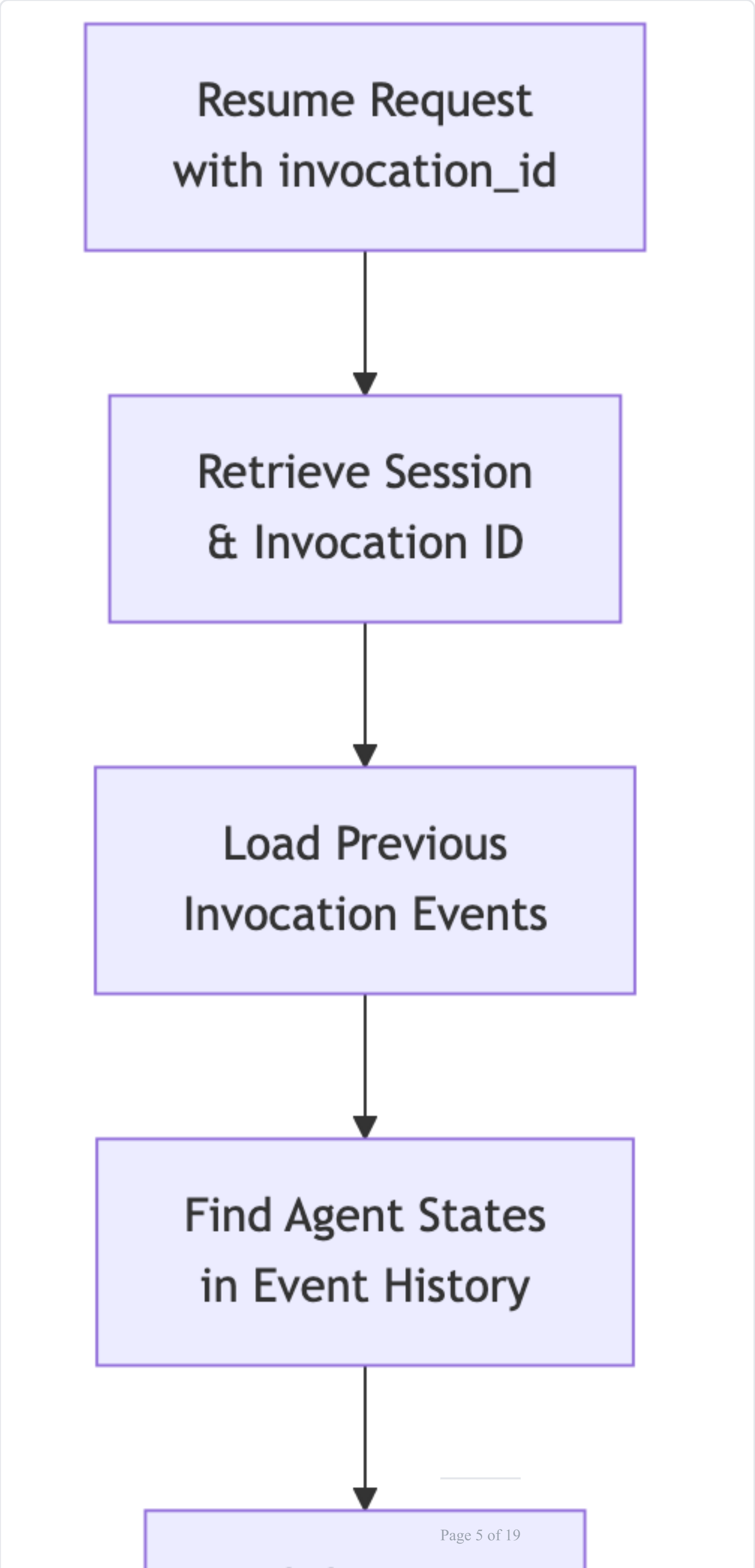
When an agent completes, it emits an event with its state:

```
event = Event(
    invocation_id='inv_1',
    author='agent_name',
    actions=EventActions(
        end_of_agent=True,           # Marks completion
        agent_state={'data': '...'}  # Persisted state
    ),
    content=response
)
```

The state is:
- **Automatic**: Framework handles it transparently
- **Serialized**: Converted to JSON for storage
- **Complete**: Includes all agent execution context

## 2. State Restoration

When resuming, the framework restores the previous state:


Resume Request with invocation_id
Retrieve Session & Invocation ID
Load Previous Invocation Events
Find Agent States in Event History

The restoration process:

1. **Find** previous invocation events in session
2. **Extract** agent_state from checkpoint events
3. **Restore** to InvocationContext
4. **Continue** agent execution with saved state

### 3. Configuration

Three simple settings to enable pause/resume:

```
from google.adk.apps import ResumabilityConfig, App

# 1. Create config
config = ResumabilityConfig(is_resumable=True)

# 2. Attach to app
app = App(root_agent=agent, resumability_config=config)

# 3. That's it! Framework handles checkpointing automatically
```

## Use Cases

### 1. Long-Running Data Processing

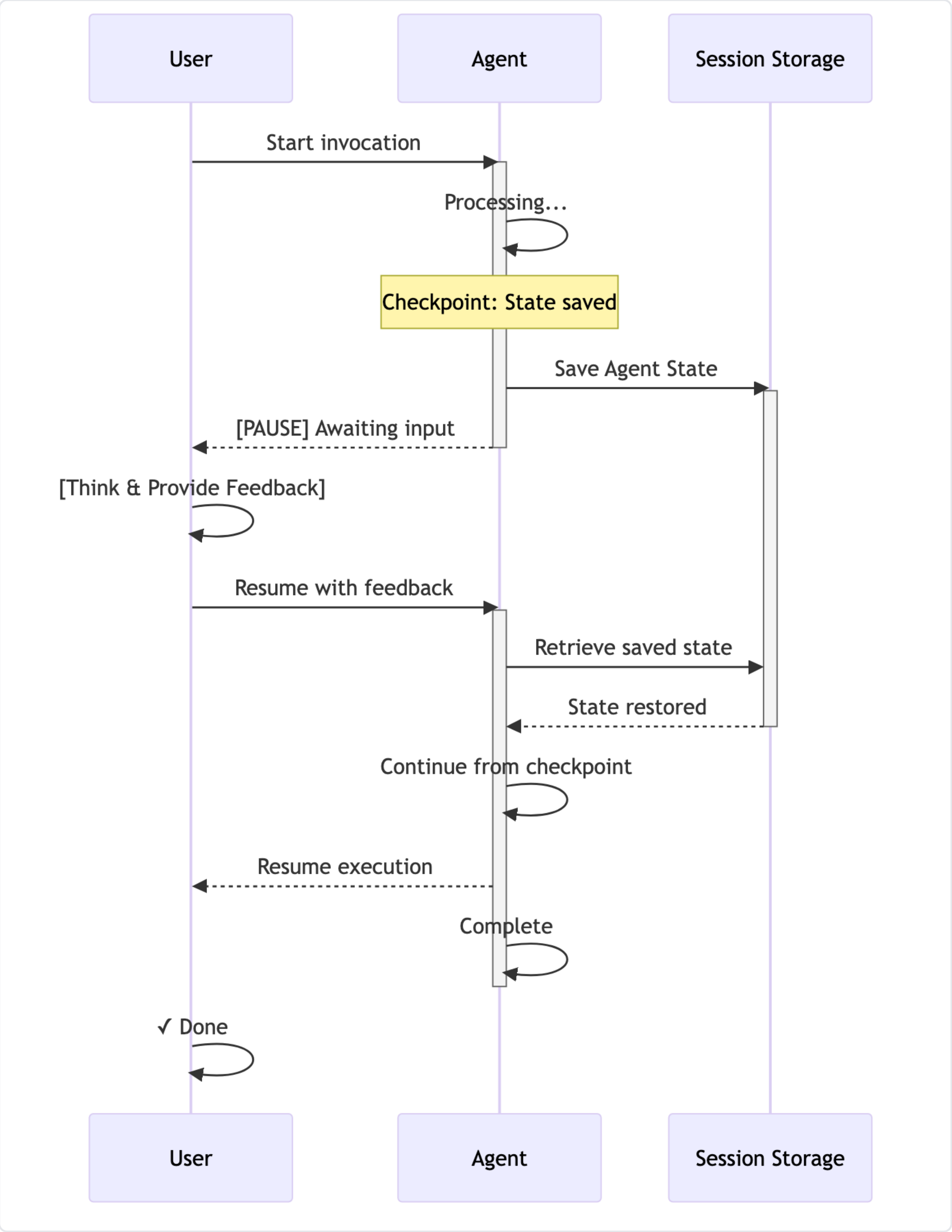
**Scenario**: Processing a large dataset in multiple stages

```
Stage 1: Validate Input     [CHECKPOINT 1]
              ↓
Stage 2: Process Data       [CHECKPOINT 2]
              ↓
Stage 3: Analyze Results    [CHECKPOINT 3]
              ↓
Stage 4: Generate Report    [CHECKPOINT 4]
              ↓
         Complete
```

If the system crashes after Stage 2, just resume with `invocation_id` from Stage 2's checkpoint.

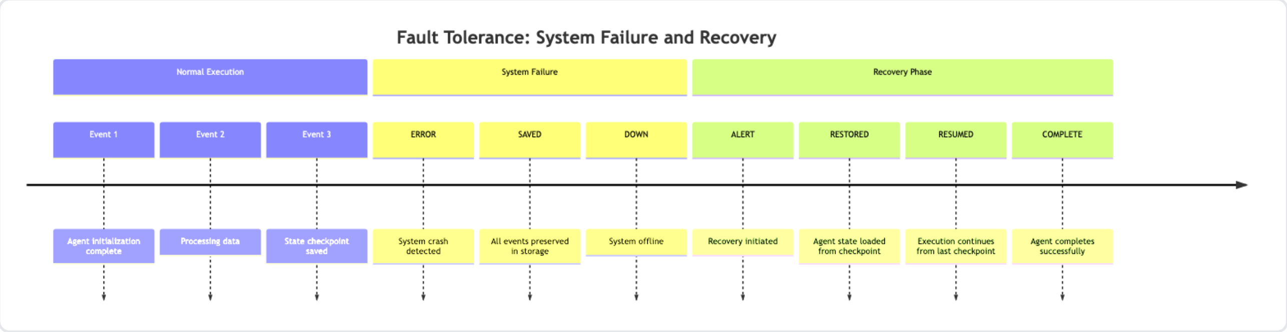
## 2. Human-in-the-Loop Approval

**Scenario**: Agent prepares decision, waits for human approval



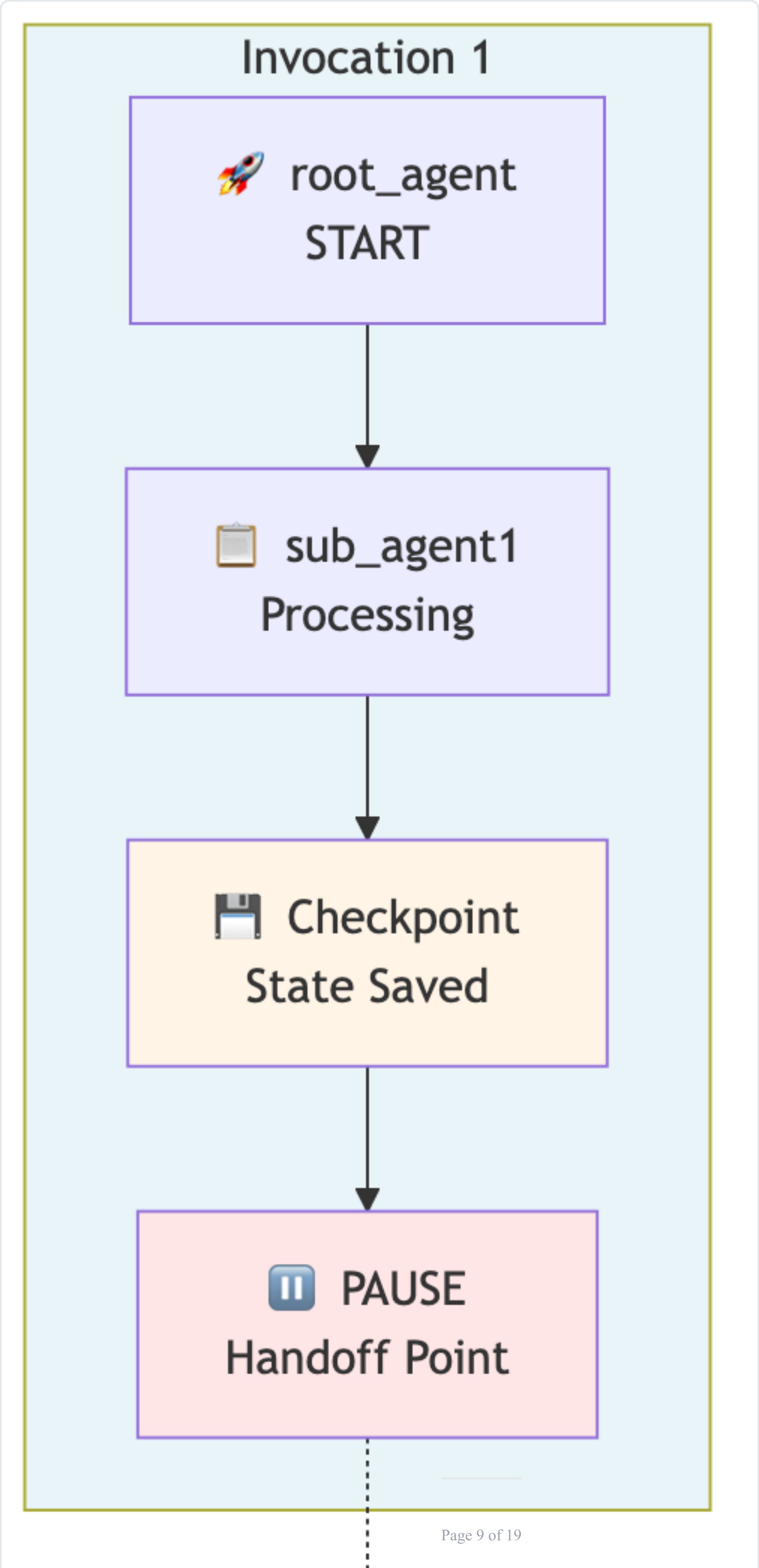
## 3. Fault Tolerance

**Scenario**: Production system with failures


Fault Tolerance: System Failure and Recovery
Normal Execution
System Failure
Recovery Phase
Event 1
Event 2
Event 3
ERROR
SAVED
DOWN
ALERT
RESTORED
RESUMED
COMPLETE
Agent initialization complete
Processing data
State checkpoint saved
System crash detected
All events preserved in storage
System offline
Recovery initiated
Agent state loaded from checkpoint
Execution continues from last checkpoint
Agent completes successfully

## 4. Multi-Agent Workflows

**Scenario**: Sequential agent handoff with state preservation


Invocation 1
🚀 root_agent
START
📋 sub_agent1
Processing
💾 Checkpoint
State Saved
⏸️ PAUSE
Handoff Point

Each agent checkpoint includes full state for potential resumption.

# Key Features

## ResumabilityConfig

```
config = ResumabilityConfig(
    is_resumable=True  # Enable pause/resume support
)
```

**That's all!** The framework handles:
- State serialization
- Checkpoint creation
- State restoration on resume
- Event history management

## Agent State Types

Different agent types have specialized states:

- **LoopAgent**: `current_sub_agent`, `times_looped`
- **SequentialAgent**: `completed_agents`, `current_index`
- **ParallelAgent**: `agent_states`, `completion_status`

Custom agents can implement their own state via:

```
class MyAgent(BaseAgent):
    def get_current_state(self) -> dict:
        return {
            'progress': self.progress,
            'data': self.accumulated_data,
            'timestamp': datetime.now()
        }
```

## Resumption with Optional New Input

Resume with new user input:

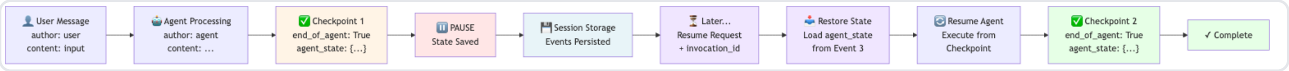
```
await runner.run_async(
    session=session,
    new_message="New feedback",           # Optional
    invocation_id=previous_invocation_id  # Required
)
```

Or resume with previous input:

```
await runner.run_async(
    session=session,
    new_message=None,                     # None = reuse
    invocation_id=previous_invocation_id
)
```

## Event Flow Example

Events flow through the session with checkpoints marked for potential resumption:



Timeline visualization:

```
Session.events = [
  Event 1: User Message (author: 'user')
    content: { text: "Process this data" }
    agent_state: None
    |
    |
  Event 2: Agent Processing
    |    author: 'agent'
    |    content: { text: "Processing..." }
    |
    v
  Event 3: Agent Complete [CHECKPOINT]
    author: 'agent'
    actions: { end_of_agent: True }
    agent_state: { "state_key": "state_value" }
    ---> SAVED IN SESSION STORAGE <---
    |
    | [PAUSE - Can Resume Here]
    |
    v
  Event 4: Resume Point
    [Later] Resumption with invocation_id
    |
    v
  Event 5: Agent Continues
    author: 'agent'
    agent_state: RESTORED from Event 3
    |
    v
  Event 6: Agent Complete [CHECKPOINT]
    author: 'agent'
    actions: { end_of_agent: True }
    agent_state: { "agent2_state": "..." }
    ---> SAVED IN SESSION STORAGE <---
]
```

## Architecture Overview

**New Components**:

- `ResumabilityConfig`: Configuration class
- `BaseAgentState`: Abstract state base class
- `LoopAgentState`, `SequentialAgentState`, `ParallelAgentState`: Specialized states
- `Runner._setup_context_for_resumed_invocation()`: Resumption logic

**Enhanced Components**:
- `App`: Now accepts `resumability_config`
- `InvocationContext`: Populates agent states from events
- `EventActions`: Includes `agent_state` field
- `Event`: Can carry agent state information

## Testing Your Implementation

The implementation includes comprehensive tests:

```
# Run all tests
pytest tests/ -v

# Run specific test
pytest tests/test_agent.py::TestAgentConfiguration -v

# With coverage
pytest tests/ --cov=pause_resume_agent
```

Expected test patterns:

```
# Test both resumable and non-resumable modes
@pytest.mark.parametrize('resumable', [True, False])
async def test_pause_resume(resumable: bool):
    config = ResumabilityConfig(is_resumable=resumable)
    app = App(root_agent=agent, resumability_config=config)
    # Test execution and checkpoint handling
```

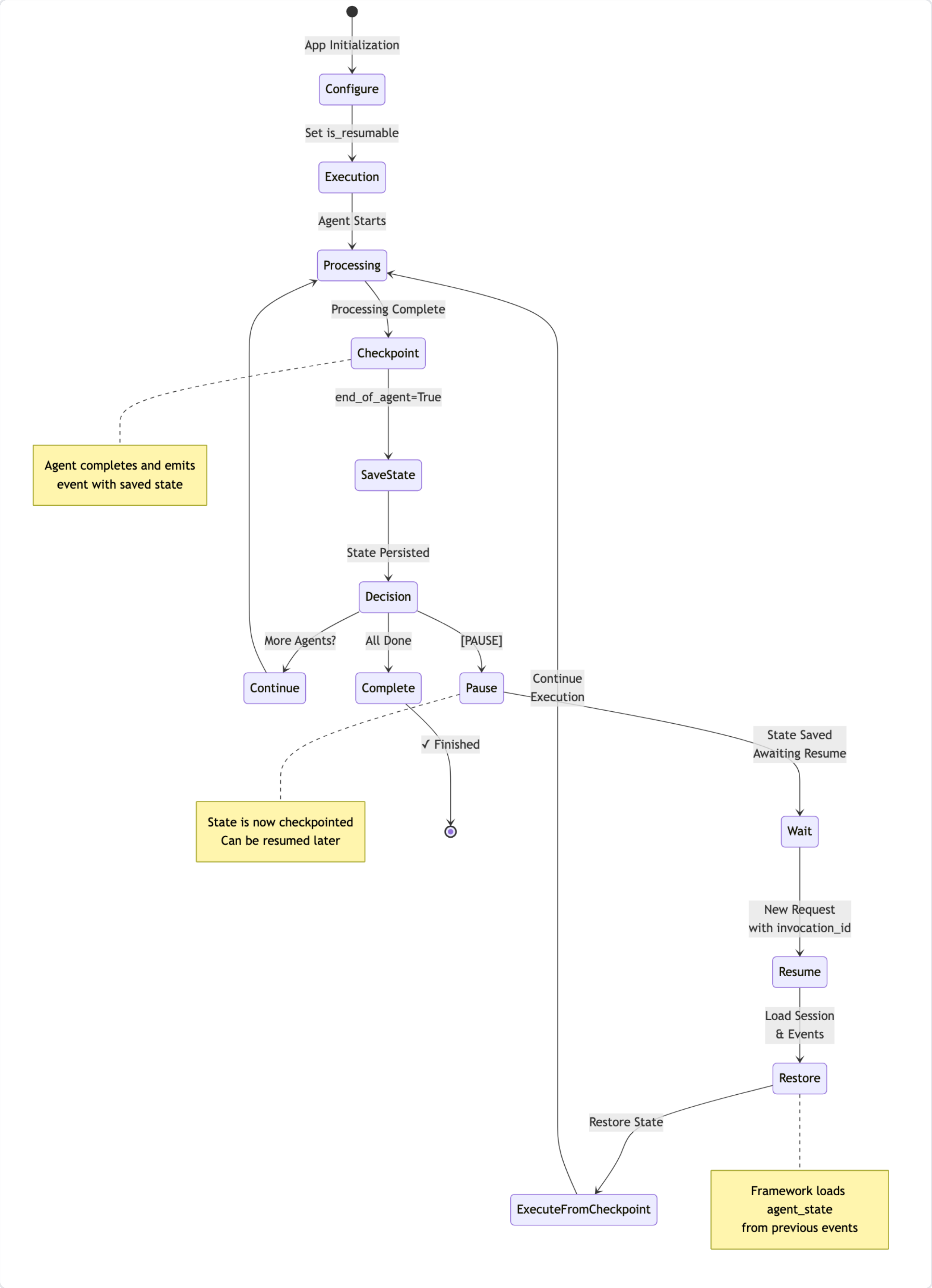
## Best Practices

1. **Always enable ResumabilityConfig if you need pause/resume** `python config = ResumabilityConfig(is_resumable=True)`
2. **Understand your checkpoint points** - Know where your agent naturally completes and saves state
3. **Test resumption scenarios** - Test both:
4. Normal execution from start
5. Resumption from checkpoint

6. **Handle state errors gracefully**
   `python try: await runner.run_async(session, invocation_id=prev_id) except StateRestorationError: # Fallback: start fresh await runner.run_async(session, new_message=original_input)`
7. **Clean up old sessions** - Archive sessions to avoid accumulation over time

## State Lifecycle

Understanding the state transition flow is crucial for building reliable pause/resume workflows:


App Initialization
Configure
Set is_resumable
Execution
Agent Starts
Processing
Processing Complete
Checkpoint
Agent completes and emits event with saved state
end_of_agent=True
SaveState
State Persisted
Decision
More Agents?
All Done
[PAUSE]
Continue
Complete
Pause
Continue Execution
✓ Finished
State is now checkpointed Can be resumed later
State Saved Awaiting Resume
Wait
New Request with invocation_id
Resume
Load Session & Events
Restore
Restore State
ExecuteFromCheckpoint
Framework loads agent_state from previous events

# Common Patterns

## Pattern 1: Simple Pause/Resume

```python
# Initial execution
async for event in runner.run_async(session, new_message=user_input):
    invocation_id = event.invocation_id

# Later: Resume
async for event in runner.run_async(
    session=session,
    new_message=new_input,
    invocation_id=invocation_id
):
    pass
```

## Pattern 2: Human-in-the-Loop

```python
# Agent pauses for feedback
await runner.run_async(session, new_message="Start process")

# Human reviews and provides input
human_feedback = request_human_input()

# Resume with feedback
await runner.run_async(
    session=session,
    new_message=human_feedback,
    invocation_id=paused_invocation_id
)
```

### Pattern 3: Fault-Tolerant Processing

```
try:
    invocation_id = None
    async for event in runner.run_async(session, new_message=data):
        invocation_id = event.invocation_id
except Exception as e:
    logger.error(f"Failed, resuming from {invocation_id}")
    # Resume from checkpoint after fix
    async for event in runner.run_async(
        session=session,
        invocation_id=invocation_id
    ):
        pass
```

## Limitations & Considerations

1. **App Configuration Required** - Must explicitly set `is_resumable=True`
2. **JSON Serialization** - Agent state must be JSON-serializable
3. **Session Storage** - Resuming requires session events from original invocation
4. **Sub-Agent Resumption** - Current limitation for resuming mid-sub-agent (documented in ADK)

## Related Features

- **Context Caching** (v1.15.0): Complement with context preservation
- **Session Management**: VertexAiSessionService, DatabaseSessionService
- **Event Streaming**: Observe checkpoint events in real-time

## Implementation Example

See the companion implementation: til_pause_resume_20251020 (https://github.com/raphaelmansuy/adk_training/tree/main/til_implementation/til_pause_resume_20251020)

**Features:**
- ✔️ Full agent implementation with checkpoint-aware tools
- ✔️ 19 comprehensive tests

- ✔️ Make commands for setup, test, dev, demo
- ✔️ Example tools: data processing, checkpoint validation, resumption hints
- ✔️ Complete documentation in README

## Quick Start with Example

```
# Clone/enter the example
cd til_implementation/til_pause_resume_20251020

# Setup
make setup

# Add API key
echo "GOOGLE_API_KEY=your_key" >> pause_resume_agent/.env

# Run tests
make test

# Launch web interface
make dev
```

## References

- **ADK GitHub**: https://github.com/google/adk-python
- **v1.16.0 Release**: https://github.com/google/adk-python/compare/v1.15.1...v1.16.0
- **Related Commits**: ce9c39f, 2f1040f, 1ee01cc, f005414, fbf7576

# Summary

Pause and Resume Invocations in ADK v1.16.0 enable building **resilient, interactive agent systems** by:

- ✔️ Checkpointing agent state automatically at completion points
- ✔️ Enabling graceful pauses for human feedback or system recovery
- ✔️ Restoring full execution context on resumption

- ✔️ Supporting long-running workflows without state loss
- ✔️ Providing fault tolerance through state persistence

This feature is essential for production agents that need reliability, human oversight, or multi-step processing workflows.

# See Also

## Related TILs

- **TIL: Context Compaction** (/docs/til/til_context_compaction_20250119) - Reduce token usage in long-running paused workflows
- **Back to TIL Index** (/docs/til/til_index) - Browse all quick-learn guides

## Related Blog Posts

- **Deploy AI Agents: Production Strategies** (/blog/deploy-ai-agents) - Understand resilience and fault tolerance in production systems
- **The Multi-Agent Pattern: Managing Complexity** (/blog/multi-agent-pattern-complexity-management)
- Understand state management across complex workflows

Generated on 2025-10-20 20:49:20 from til_pause_resume_20251020.md

Source: Google ADK Training Hub